AD-A175 134 CARRIER BATTLE GROUP (CVBG) HOMEPORTING IN THE PUGET SOUND AREA WASHINGTON STATE VOLUME 1 CHAPTERS 1-12(U) CORPS OF ENGINEERS SEATTLE WA SEATTLE DISTRICT NOV 86 1/4

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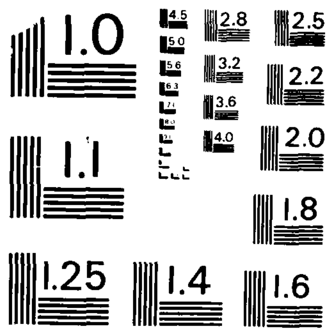

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Final Supplemental to U.S. Navy Environmental Impact Statement Carrier Battle Group Puget Sound Region Ship Homeporting Project

Volume 1
Chapters 1-12

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US Army Corps
Of Engineers
Seattle District

November 1986

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This EIS provides information on the proposed Everett homeport project, along with information on dredge disposal sites and methods. These aspects of the project are evaluated for their impacts on the community and the natural environment.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

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DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE, WASHINGTON 98124-2255

6 NOV 1986

REPLY TO
ATTENTION OF

Planning Branch

Dear Reviewer:

Enclosed for your review and comment is the Federal final environmental impact statement supplement (EISS) titled "Final Supplemental to U.S. Navy Environmental Impact Statement, Carrier Battle Group, Puget Sound Region Ship Homeporting Project" (enclosure 1).

We request that any comments you may have on this document be returned to this office on or before December 15, 1986, or such later date as may be necessary to total 30 days after Environmental Protection Agency (EPA) publication of the Notice of Availability in the Federal Register. The Federal Register announcement is expected to occur on November 14, 1986. Technical appendixes for the final EISS have been included in this mailing for appropriate Federal and state agencies, local governments (including Indian nations), environmental interest groups, and to those private citizens who specifically requested them. Copies of the technical appendixes are available for review at the Seattle District Library, U.S. Army Corps of Engineers, 4735 East Marginal Way South, Seattle, Washington; Commander Naval Base Seattle, 7500 Sand Point Way Northeast, Building 192, Seattle, Washington; Everett Public Library, Documents Librarian, 2702 Hoyt, Everett, Washington; Seattle Public Library, Government Documents Librarian, 1000 Fourth Avenue, Seattle, Washington; Snohomish County Library, Marysville Branch, 4811 72nd Street Northeast, Marysville, Washington; Snohomish County Library, Lynwood Branch, 19200 44th Avenue West, Lynwood, Washington; Washington State Library, Reference Department, State Library Building, Olympia, Washington; and University of Washington, Government Documents Division, Suzzalo Library, Seattle, Washington.

This EISS was prepared because the U.S. Army Corps of Engineers determined that additional information was necessary before a decision on the Navy's permit application to the Corps of Engineers could be made. The Seattle District, Corps of

Engineers, has officially adopted the U.S. Navy's EIS that was published in June 1985. The U.S. Navy's EIS is available for review at the libraries listed above. Limited copies are also available from the U.S. Navy, Naval Base Seattle, NAVFAC Home-porting Office, 7500 Sand Point Way Northeast, Seattle, Washington 98115.

Any questions regarding the final EISS should be directed to Dr. Stephen Martin, Environmental Resources Section, telephone (206) 764-3624, or to the above address.

Sincerely,

James M. Cullem
Lt. Colonel, Corps of Engineers
Acting District Engineer

Enclosure

NOTE TO
FINAL ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT
(FEISS) READERS

Recent actions by Congress concerning the funding of the U.S. Navy's homeport project will have an impact on the construction schedule, as proposed by the U.S. Navy and as discussed in this FEISS, if a permit is ultimately issued for this project. Due to funding limitations, environmental constraints and recommendations by the Washington Department of Ecology, the Navy still plans to dredge over at least a two year period to allow the results of monitoring the first year's confined aquatic disposal to be evaluated. The specific start of dredging projects in Fiscal Year (FY) 87 and FY88, referred to numerous times in the FEISS, would be better understood if described simply as the first and second years of dredging.

The Seattle District, U.S. Army Corps of Engineers has reviewed this FEISS in light of the funding restrictions and has concluded that the basic premises and environmental evaluations contained in this document are still valid. The impact of the Congressional FY87 funding constraints will be considered in arriving at a decision on the U.S. Navy's Department of the Army permit application.

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FINAL

ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

CARRIER BATTLE GROUP (CVBG) HOMEPORTING

IN THE PUGET SOUND AREA,

WASHINGTON STATE

U.S. ARMY
CORPS OF ENGINEERS
SEATTLE DISTRICT

Corps of Engineers Permit Action
Per Section 10 of the Rivers
and Harbors Act of 1899 and
Section 404 of the Clean Water Act

NOVEMBER 1986

INTRODUCTION

A. <u>Action Sponsor/Permit Applicant</u>:

U.S. Navy
Director, Pacific Northwest Branch Office
Western Division
Naval Facilities Engineering Command
P.O. Box 2366
Silverdale, WA 98383

B. <u>Nature of Proposal/Abstract</u>: The Puget Sound area was proposed as the site to homeport a 15 ship Carrier Battle Group (CVBG) as a result of the Navy's Expansion Program (to a 600-ship Navy) and a policy to decentralize future Naval forces. Puget Sound provides the Navy with an established Naval support complex, protected deep waterways, and existing industrial, commercial, and transportation networks, requirements which are all vital to the establishment of a Navy Station.

The purpose of this Environmental Impact Statement Supplement (EISS) is to provide information on the proposed Everett homeport project, along with information on dredge disposal sites and methods. This EISS evaluates these aspects of the project and their impacts on the community and the natural environment.

In September 1983, the Navy formed a site selection team to evaluate Puget Sound sites, based on the following criteria: Naval operation compatibilities, logistics support, operational costs, community support, environmental impacts, construction costs, and waterfront and land availability. Of the many sites investigated, only the Port of Seattle's Terminal 90-91 complex and the Port of Everett's Norton Avenue Terminal provided the Navy with feasible alternative locations to homeport a Carrier Battle Group. These two alternative sites were discussed in detail in the Navy FEIS, published in June of 1985. The U.S. Army Corps of Engineers has adopted that document as part of the preparation of this supplement.

This study was prepared under the requirements of the National Environmental Policy Act (NEPA) of 1969, the Council on Environmental Quality regulations (40 CFR 1500-1508) issued November 29, 1978, and the U.S. Army Corps of Engineers' regulations for compliance with NEPA (33 CFR Part 230) dated August 25, 1980.

C. <u>Lead Agency</u>: Seattle District, U.S. Army Corps of Engineers.

Cooperating Agency: U.S. Navy

D. Person at U. S. Army Corps of Engineers Who Can Supply Further Information:

Thomas F. Mueller
Regulatory Branch
Seattle District
U.S. Army Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124
(206) 764-3495

E. Permits and Approvals Required

Federal

1. Section 10 and Section 404 Permit

The U.S. Army Corps of Engineers has regulatory authority over all construction activities in navigable waters of the United States. Section 10 of the Rivers and Harbors Act of 1899 pertains to regulation of dredging, filling and construction of floats, piers and other structures. Section 404 of the Clean Water Act of 1977 (Public Law 95-217) applies to the discharge of dredge or fill material.

2. Fish and Wildlife Coordination Act

Section 2 of the Fish and Wildlife Coordination Act (16 USC 661-666) directs federal agencies to consult with the U.S. Fish and Wildlife Service and state agencies before authorizing alterations to water bodies. The purpose of the act is to see that wildlife conservation receives equal consideration, and that it be coordinated with other features of water resource programs.

3. Endangered Species Act of 1973

Section 7 of the Endangered Species Act of 1973 (as amended) requires federal agencies to ensure that their actions do not jeopardize endangered or threatened species or their critical habitats. If it is shown that a project would be likely to affect endangered or threatened species (either adversely or beneficially), the agency must consult with the USFWS and NMFS to ensure that such species and their critical habitats would be conserved.

4. National Pollutant Discharge Elimination System Permit (NPDES)

The National Pollutant Discharge Elimination System (40 CFR 122 and 124) under the Clean Water Act, 33 USC 1251, regulates the discharge of pollutants into the waters of the United States. Any person who discharges or proposes to discharge pollutants into waters of the United States must obtain a NPDES permit from the U.S. Environmental Protection Agency or the delegated State authority. The permittee must properly operate and maintain all facilities and systems of treatment and control which are installed to achieve compliance with the conditions of the permit. The permittee must take all reasonable steps to minimize or prevent any discharge in violation of the permit which has a reasonable likelihood of adversely affecting human health or the environment. Storm water point sources are subject to the NPDES permit program.

5. The Clean Air Act

The Clean Air Act, as amended (42 USC 1857 et seq.), sets the basic framework for federal, state, and local air quality management programs. The major implementation provision of the Clean Air Act requires each state to establish and implement a plan to achieve the federal ambient air quality standards within specified time frames. The resulting "state implementation plans" provide the basic regulatory programs for controlling pollutant emissions from existing and future emission sources. The scope of state control programs depends partially on current air quality conditions in various subareas of a state.

<u>State</u>

1. State Waste Discharge Permit

Per Chapter 173-216 WAC State Waste Discharge Program, the discharge of domestic wastewater, containing industrial wastes, into a municipal sewerage system requires the filing of an application with the Washington Department of Ecology (WDOE) for a State Waste Discharge Permit. The application requires information on predicted wastewater flow quantities and chemical/biological characteristics, and enables WDOE to evaluate whether the wastewater discharge will interfere with, pass through, or otherwise be incompatible with the municipal system.

2. Construction of Domestic Wastewater Facilities

Per Chapter 173-240 WAC, proposed domestic wastewater facilities must be designed, constructed, operated, and

maintained to meet Washington Department of Ecology (WDOE) guidelines and to meet effluent limitations and other requirements of the State Waste Discharge Permit. An engineering report and plans and specifications describing the proposed facilities are submitted to WDOE for its review and comment.

3. Construction of Industrial Wastewater Facilities

Per Chapter 173-240 WAC, proposed industrial wastewater facilities must be designed, constructed, operated, and maintained to meet Washington Department of Ecology (WDOE) guidelines and to meet effluent limitations and other requirements of the State Waste Discharge Permit. An engineering report and plans and specifications describing the proposed facilities are submitted to WDOE for its review and comment.

4. Notification of Dangerous Waste Activities

Per Chapter 173-303 WAC Dangerous Waste Regulations, anyone who generates or transports hazardous waste, or who owns or operates a facility for transferring, treating, storing, or disposing of hazardous waste must notify the U.S. Environmental Protection Agency (EPA) and the Washington Department of Ecology (WDOE) of their activity. This notification is accomplished through the filing of a "Notification of Dangerous Waste Activity Form 2" with WDOE. WDOE will coordinate with EPA and issue an EPA/State Identification Number to the applicant. The identification number is an integral part of the management and tracking of hazardous waste from the time it is generated to the time it is properly disposed of in accordance with the intent of the Resource Conservation and Recovery Act (RCRA).

5. Notice of Construction and Application for Approval (New Air Pollution Sources)

In an effort to control emissions of air contaminants from all sources within their jurisdiction, the Puget Sound Air Pollution Control Agency (PSAPCA) requires that all new sources (unless specifically exempted) and their associated control devices must be registered with and approved by this agency prior to construction in accordance with PSAPCA Regulation 1, Section 6.03. New sources and control equipment are evaluated to determine conformance with New Source Performance Standards and Best Available Control Technology guidelines.

6. Prevention of Significant Deterioration (PSD) Permit

New air contaminant sources and associated control equipment must be registered with and approved by the appropriate local air pollution authority. Additionally, new sources to be constructed in or near areas that meet National Ambient Air Quality Standards must be reviewed to determine if further evaluation under the Prevention of Significance Deterioration (PSD) program administered by Washington Department of Ecology (WDOE) is applicable. Only sources that are a designated PSD source category or that emit significant quantities of air pollutants are evaluated under the PSD program to determine their impact on local air quality. Modeling is required for pollutants subject to PSD review.

7. Construction of a Public Water System

Chapter 248-54 WAC Public Water Supplies requires that the design of any portion of a new public water system, or additions, extensions, changes, or alterations to an existing public water system, must conform to the applicable Washington Department of Social and Health Services (WDSHS) design standards. An engineering report and plans and specifications are submitted to WDSHS for their review and comment.

8. Coastal Zone Management Consistency Certification

Federal agencies proposing development which will directly affect the Washington Coastal Zone must certify that its proposal is "consistent to the maximum extent practicable" with the approved state coastal zone CZM program. This certification is submitted to the Washington Department of Ecology (WDOE) in the form of a Coastal Consistency Determination (CCD). The CCD must include a detailed description of the proposed action, its associated facilities, and their combined coastal effects. A federal agency's conclusion that their proposal is "consistent to the maximum extent practicable" must be based upon an evaluation of the relevant provisions of the state management program.

9. Water Quality Certification (Short-Term Exception to Water Quality Standards)

Prior to the issuance of a U.S. Army Corps of Engineers (COE) Permit, the Washington Department of Ecology (WDOE) may issue a Water Quality Certification certifying that the proposed actions described in the U.S. Army Corps of Engineers' public notice will not result in water quality degradation and non-compliance with water quality standards. The U.S. Army Corps of Engineers' public notice may describe

the mitigation measures planned to minimize any impacts. However, certain construction activities, such as dredging, will result in the temporary violation of water quality standards even when appropriate mitigation measures are employed. These activities cannot proceed unless WDOE issues a Short-Term Exception to Water Quality Standards in conjunction with the Water Quality Certification.

10. Hydraulic Project Approval

Chapter 220-110 WAC Hydraulic Code Rules establishes criteria that the Departments of Fisheries and Game have developed for the protection of fish life. These criteria are used for the review of hydraulic projects and the conditioning of Hydraulic Project Approvals. The public notice issued during the U.S. Army Corps of Engineers permit process can function as a permit application for a Hydraulic Project Approval. A Hydraulic Project Approval must be issued by the Departments of Fish and Game before a permit will be issued by the U.S. Army Corps of Engineers.

11. Archaeological Approval

The Washington State Office of Archaeology and Historic Preservation (WSOAHP), in coordination with the Federal Advisory Council on Historic Preservation, has the authority to review project proposals to determine whether or not there are potential impacts on archaeological or historical resources. If impacts are anticipated, appropriate mitigation measures can be required. This approval is normally addressed through the NEPA/SEPA process.

12. State Environmental Policy Act (SEPA)

Projects determined to have a potentially significant impact on the environment are required to prepare an environmental impact statement. The current SEPA rules (April 1984) provide for adoption of NEPA documents to satisfy SEPA (197-11-610 WAC). The City of Everett and/or the Washington Department of Ecology would have the responsibility for further action under SEPA. The state of Washington and City of Everett has prepared a supplement to the Navy FEIS to satisfy SEPA requirements.

13. <u>Open Water Disposal Site Permit</u>

Per Chapter 332-30 WAC Aquatic Land Management, the Washington State Department of Natural Resources (DNR) acts as proprietor of state-owned aquatic lands. DNR authorizes water disposal sites by permit issuance in accordance with siting guidelines established in WAC 332-30-166(10) and on advice of the Interagency Open Water Disposal Site Evalua-

tion Committee. Based on the permit application, DNR obtains local shoreline permits and acts as lead agency under the State Environmental Policy Act. The open water disposal site permit is issued after the U.S. Army Corps of Engineers Section 10/404 permit signifies that all other permit requirements have been satisfied.

City of Everett

There are a number of local capital improvements required for the proposed homeport such as roads and utility connections to the City of Everett's potable water and domestic sewage system. The Navy will negotiate formal contracts with the City of Everett regarding the provision of suitable municipal service and responsibility for payment. There will be ample opportunity for the City of Everett to review and comment on the Navy's plans and specifications for such capital improvements.

Navy consistency with the City of Everett's Shoreline Management Plan and information required for the Substantial Development Permit will be covered in the Navy's Coastal Consistency Determination previously discussed in the State Permit/Approval section of this chapter.

F. Location of EISS and Background Data: Copies of the final NEPA EISS are available for inspection at the main office of the Seattle District U.S. Army Corps of Engineers library, 4735 E. Marginal Way S., Seattle, WA; the City of Everett public library, Everett, WA; the Governmental Research Assistance library in the Suzallo Library at the University of Washington, Seattle, WA., and Naval Station Seattle (Sand Point). The primary background data for the final EISS is included in technical appendices. The technical appendices, available for inspection at the locations listed above, have been sent to all agencies making decisions on permits and approvals. Additional background information is on file with the Seattle District Corps of Engineers.

G. Comments on Document and Closing Date: Comments on this document should be sent to:

Dr. Stephen Martin
Environmental Resources Section
Seattle District
U.S. Army Corps of Engineers
P.O. Box C-3755
Seattle, WA 98124
(206) 764-3625

The official closing date is 30 days from the date on which the notice of availability appears in the Federal Register. The Federal Register announcement is expected to occur on 14 November, 1986.

H. Contractor's Disclosure Statement: A team of consultants from various firms (see List of Preparers in this section), coordinated by Ramon Beluche of Parametrix, Inc., has prepared the major input to the U.S. Army Corps of Engineers' environmental impact statement for permit application number 071-OYB-2-010288. The application was submitted by the Department of the Navy for a proposed Carrier Battle Group Homeport in Everett, Washington.

I certify that neither I nor other members of the project team have any financial or other interest in the outcome of this project.

October 30, 1986 — Ramon A. Beluche

DATE — SIGNATURE

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PREFACE

In June 1985 the U.S. Department of the Navy, Western Division, Naval Facilities Engineering Command, issued the final environmental impact statement (FEIS) for the Carrier Battle Group Puget Sound Region Ship Homeporting Project. The Navy FEIS identified Everett, Washington, as the preferred location for siting a carrier battle group comprised of up to 15 ships.

In September 1985 the Department of the Navy filed a permit application with the Department of the Army, Corps of Engineers, for construction of structures in waters, dredging, and disposal of dredge materials. The U.S. Army Corps of Engineers has regulatory authority over all construction in waters of the United States as authorized by Section 10 of the River and Harbor Act of 1899, which pertains to dredging, filling, and construction of floats, piers, and other structures, and Section 404 of the Clean Water Act of 1977, which applies to the discharge of dredge or fill material. The U.S. Army Corps of Engineers published a public notice (071-04B-2-010288) dated October 15, 1985. Based in part on comments received on the public notice from governmental agencies and the public, the U.S. Army Corps of Engineers prepared an environmental assessment of the proposed project.

The U.S. Army Corps of Engineers subsequently determined that additional information about the project, particularly on the subject of dredging and dredge disposal, was needed before a decision on the permit application could be made. Accordingly, the U.S. Army Corps of Engineers gave public notice that an environmental impact statement supplement (EISS) was to be prepared. The notice of intent to prepare a supplement to the Navy FEIS was published in the Federal Register on January 27, 1986. The U.S. Army Corps of Engineers invited comments on the scope of the document from the public and governmental agencies. In this regard, the U.S. Army Corps of Engineers also officially adopted the Navy EIS when the Draft EISS was published.

The scope of the EISS has therefore been limited to the following issues:

- Dredging and dredge disposal impacts, including:
    - detailed characterization of dredge materials;
    - assessment of dredging methods;
    - evaluation of disposal sites from both environmental and engineering perspectives;
    - modeling of dredge disposal deposition.
- Clarification of the Navy's Puget Sound homeport site alternative analysis

- o Assessment of water quality impacts from:
  - dredging;
  - dredge material disposal;
  - graywater discharge from certain ships;
  - organotin paints used on hulls of ships.

- o Additional evaluation of impacts on fisheries resources:
  - crab studies conducted since the Navy FEIS;
  - project design issues and mitigation;
  - dredging impacts;
  - dredge disposal impacts at alternative sites;
  - project operations impacts;
  - secondary impacts on the Port of Everett.

- o Updated air quality impacts from:
  - construction emissions;
  - operational emissions;
  - traffic related emissions from the City of Everett's proposed homeport access route alternative.

- o Updated endangered species impacts;
  - construction, dredging, and operational impacts on bald eagles;
  - construction, dredging, and operational impacts on marine mammals.

- o Additional information on soils and geology for:
  - project site impacts;
  - disposal site impacts.

- o Additional information on Native American concerns and mitigation

- o Updated traffic and transportation information to include the City of Everett's proposed homeport access route

- o Update of population and housing information:
  - review of the Navy FEIS population distribution;
  - inclusion of information from the PSCOG housing study;
  - additional data on urban expansion impacts;

- update of community service impacts using information from the homeport fiscal impact analysis;
- assessment of impacts on University of Washington housing near Naval Station Seattle.

o Assessment of secondary impacts on the Port of Everett's operations

o Updated assessment of impacts and mitigation measures pertaining to the City of Everett's sewage treatment plant

o Update of project related nuclear hazards.

The Draft EISS, prepared by the U.S. Army Corps of Engineers, was released in July 1986. A 45-day public response period followed, in which the public, federal, state and local agencies and organizations commented on the information provided in the Draft EISS. Revised public notices were circulated for public comment on July 9, 1986, and October 7, 1986.

Based upon Dungeness crab data provided by the University of Washington's ongoing marine studies in Port Gardner Bay, a new preferred dredge spoil disposal alternative has been developed and evaluated in this document. The new disposal site will use the Contained Aquatic Disposal (CAD) technology presented in the Draft EISS, but will apply it to a deeper site adjacent to the Deep Delta CAD site. The new alternative is described in detail in Chapter 2 of this document.

The following subject areas have been revised and are reprinted in the following chapters of this document:

Chapter 3 - Dredging and Dredge Disposal Analysis
Chapter 4 - Water Quality Impacts
Chapter 5 - Fisheries Resources Impacts
Chapter 6 - Air Quality Impacts
Chapter 7 - Port of Everett Relocation Activities
Chapter 8 - Native American Concerns
Chapter 9 - Traffic and Transportation
Chapter 10 - Population and Housing
Chapter 11 - Nuclear Concerns
Chapter 12 - Unavoidable Impacts and Mitigations

Comments on the Draft EISS received during the August 19, 1986 public hearing and submitted in writing during the public review period have been reprinted in Chapter 13. Responses to comments appear directly alongside each comment.

1. SUMMARY

This section contains a summary of the project; including a project description, purpose and need for the project, and impacts associated with it. Detailed discussions of the project and related issues can be found in the appropriate sections of this document.

1.1 Summary of Project Description

The proposed project site (Norton Avenue Terminal Site) is located in Puget Sound within the City of Everett, Washington (Figures 1-1 and 1-2). The site is located on the east side of Port Gardner Bay, just west of the central downtown area. At present, the site is principally owned and operated by the Port of Everett as a waterfront industrial and shipping site. Although the site is located in the mouth of the Snohomish River estuary, deep water for navigation purposes is available near the site.

Operation of a Carrier Vessel Battle Group homeport at the site would require newly constructed facilities to accommodate 15 ships, plus up to 10 additional small crafts needed for support services.

Since each part of the fleet will have different work schedules, the number of personnel and vessels in port at any one point in time will fluctuate. Actual homeport staffing could range from about 1300 while the battle group was on cruise, to almost 10,400 at peak periods when the battle group and destroyer tender are in port.

Approximately 50 percent of the military population assigned to ships at the Everett site are expected to reside aboard their ships. An additional 465 personnel assigned to the homeport are expected to reside in the BEQ (Bachelor Enlisted Quarters) on-site. The remainder of the military and civilian personnel and their dependents are expected to reside elsewhere.

When in port, most ships would be in "cold-iron" or "hoteled" status at their berths. When hoteled, a berthed ship receives all utilities and collection systems from shore-based facilities.

Location of a homeport facility at the 117 acre Norton Avenue Terminal site, in Everett would require construction of many support facilities. The existing facilities located at the Norton Avenue Terminal site are shown on Figure 1-3. Figure 2-1 shows a preliminary concept of how the facilities would be arranged at the proposed homeport site.

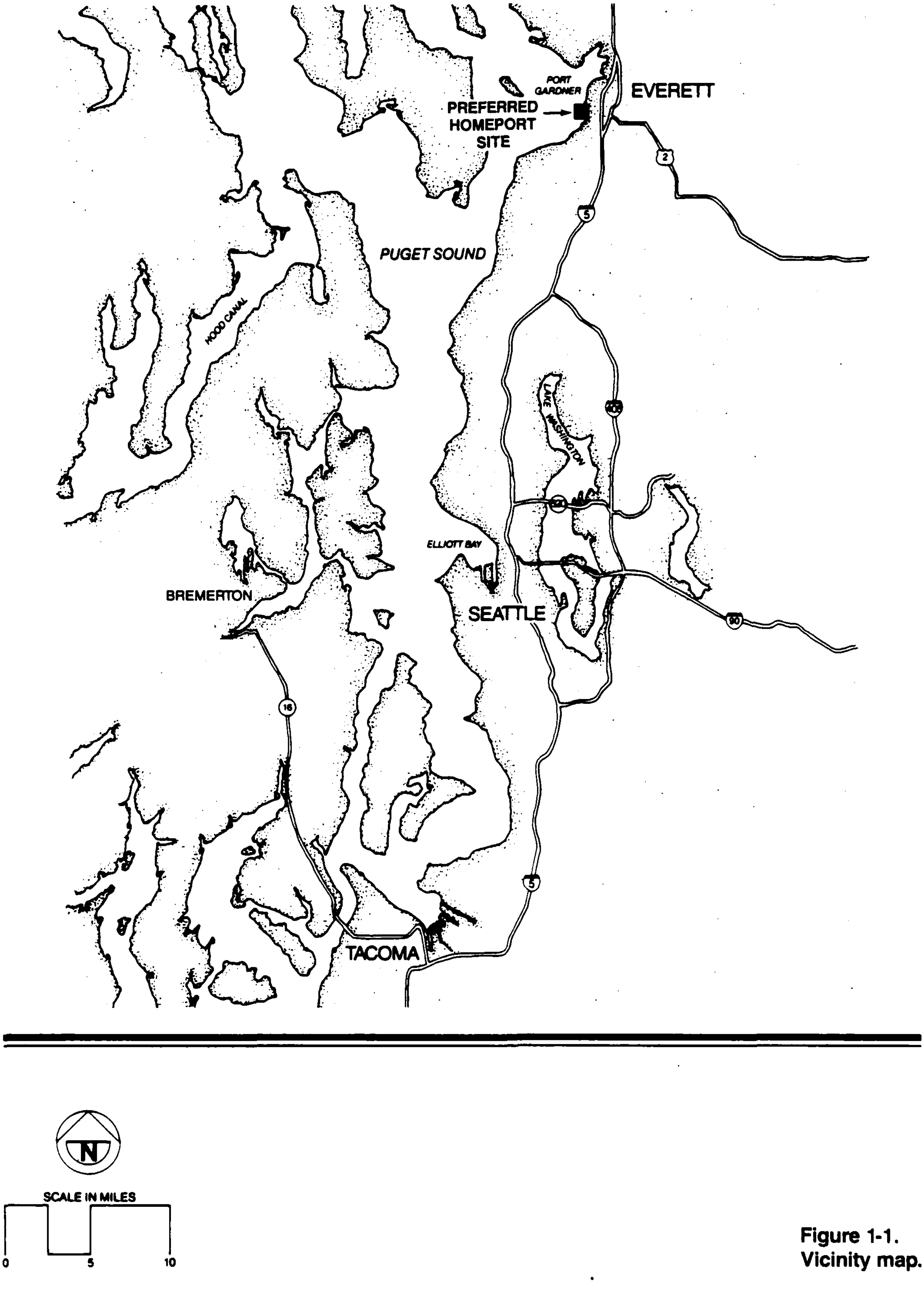


Figure 1-1.
Vicinity map.

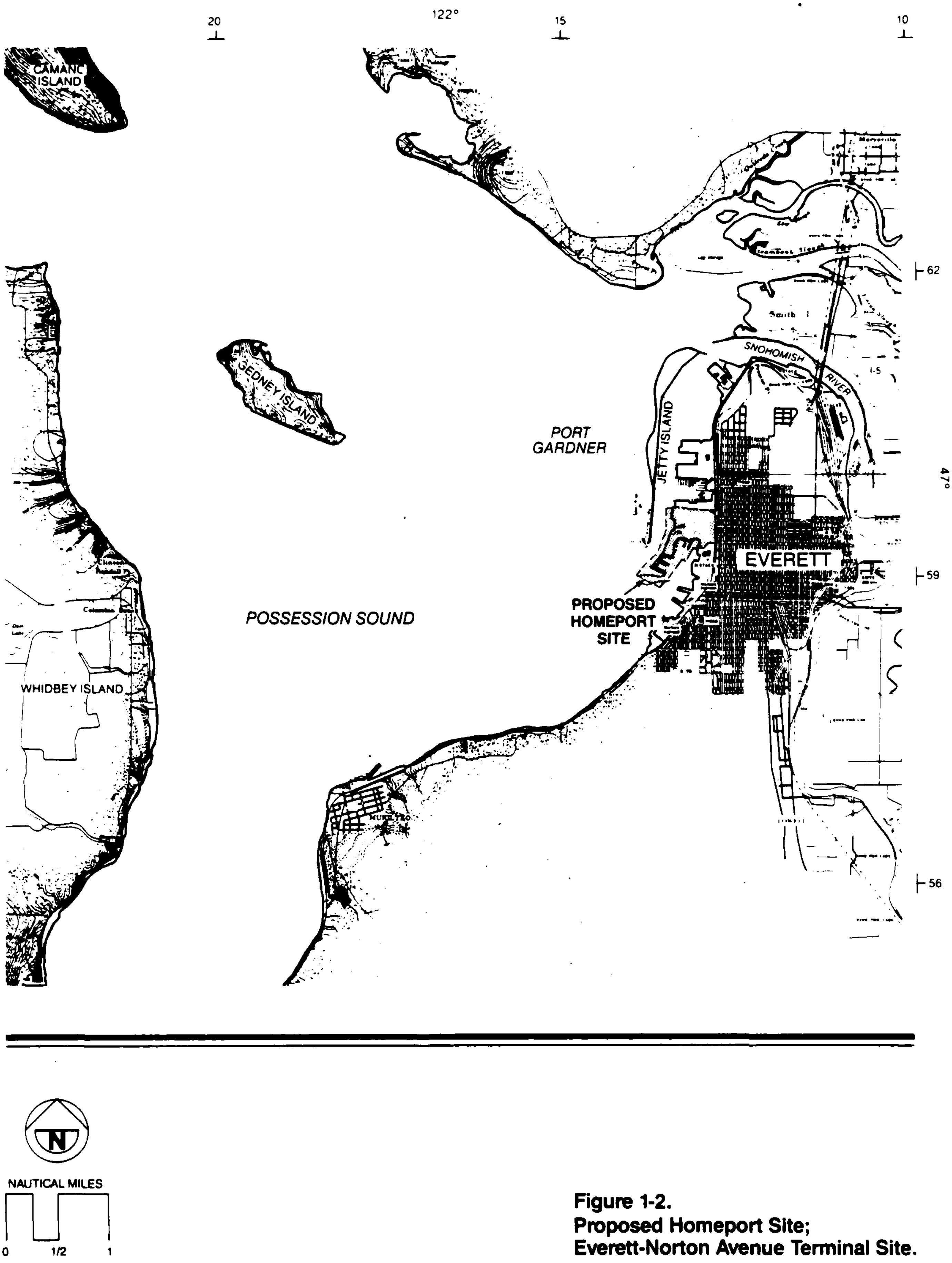


Figure 1-2.
Proposed Homeport Site;
Everett-Norton Avenue Terminal Site.

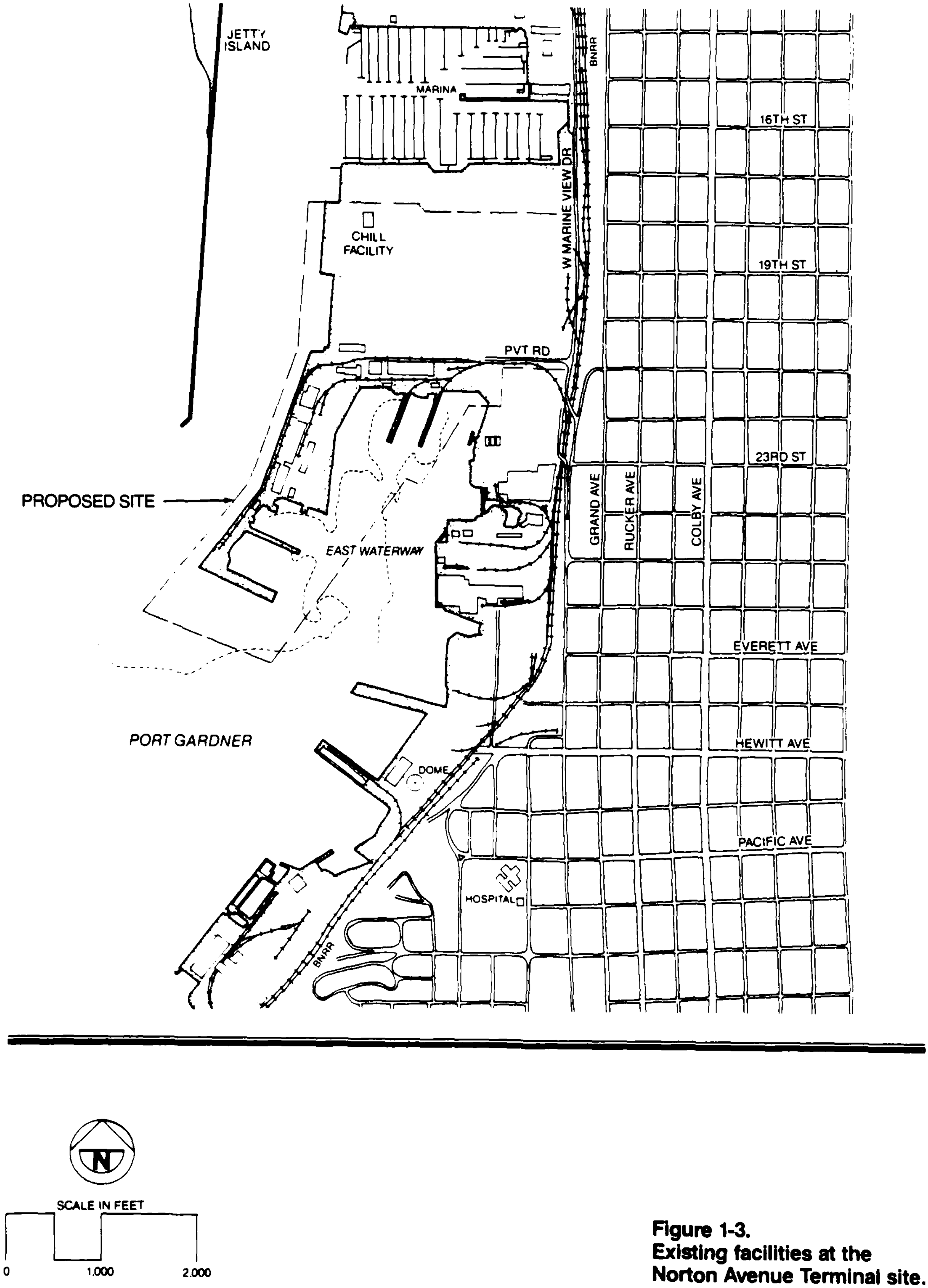


Figure 1-3.
Existing facilities at the Norton Avenue Terminal site.

Construction activities at the homeport site would involve demolition of almost all existing buildings on-site and construction of new buildings, utilities, parking areas and recreational facilities. Reconstruction and removal of existing piers along with construction of a new pier and breakwater would also be necessary.

Approximately 3,305,000 cubic yards of sediment would have to be removed to provide the necessary depth for vessel handling, and to expose suitable foundation for the construction of the breakwater, and piers. It is proposed that contaminated surface sediments will be removed first by a clamshell dredge which would allow minimal contact of contaminated sediments with the water column, and then the clean sediments will be removed via either a hydraulic or clamshell dredge and deposited using either a pipeline with diffuser or a pumpout barge.

A number of disposal methods and site alternatives are being considered for the removed sediments. The preferred method is to dispose of the contaminated sediments at a deepwater site and then "cap" them with the clean sediments. This method is termed confined aquatic disposal or CAD. These CAD sites are evaluated in this document: Revised Application Deep (RAD) CAD, Deep Delta (DD) CAD nad Southwest Deep (SW) CAD. The preferred disposal alternative, RAD CAD, was developed after issuance of the DEISS and is in response to comments concerning potential significant impacts to the Dungeness crab resource of Port Gardner associated with the DD CAD site. The RAD CAD site is located in the same general area as the DD and SW CAD sites, but at a depth sufficiently deep to minimize short-term and avoid long-term impacts to Dungeness crab resources.

A second method involves placing either all of the removed sediments or just the contaminated sediments in an intertidal site on the Snohomish River. If only the contaminated sediments were placed there, the clean sediments would be taken to the existing Port Gardner aquatic disposal site if it is open. Another alternative being considered would utilize the intertidal disposal method and create an intertidal disposal area in the East Waterway for the contaminated sediments. Since this site would not have the capacity to handle all of the contaminated sediments, a portion of the Snohomish River site or the RAD CAD site would also be required for placement of the removed sediments. The final disposal method involves placement of the contaminated sediments in an upland site on Smith Island. With this alternative and the East Waterway alternative, clean sediments could be disposed of at a deep water site in Port Gardner.

1.2 Authority and Jurisdiction

The U.S. Army Corps of Engineers has regulatory authority over all construction activities in or affecting waters of the United States. The U.S. Army Corps of Engineers' authority over this project is derived from two laws. Section 10 of the Rivers and Harbor Act of 1899 applies to the construction of piers, bulkheads, breakwaters, and other structures; dredging and disposal of dredged material and filling in navigable waters of the United States. Section 404 of the Clean Water Act of 1977 applies to the discharge of dredged or fill material into waters of the United States. The applicant applied to the U.S. Army Corps of Engineers for a Department of the Army permit under both Section 10 and Section 404 to dredge, fill, and construct facilities on Port Gardner Bay in the City of Everett.

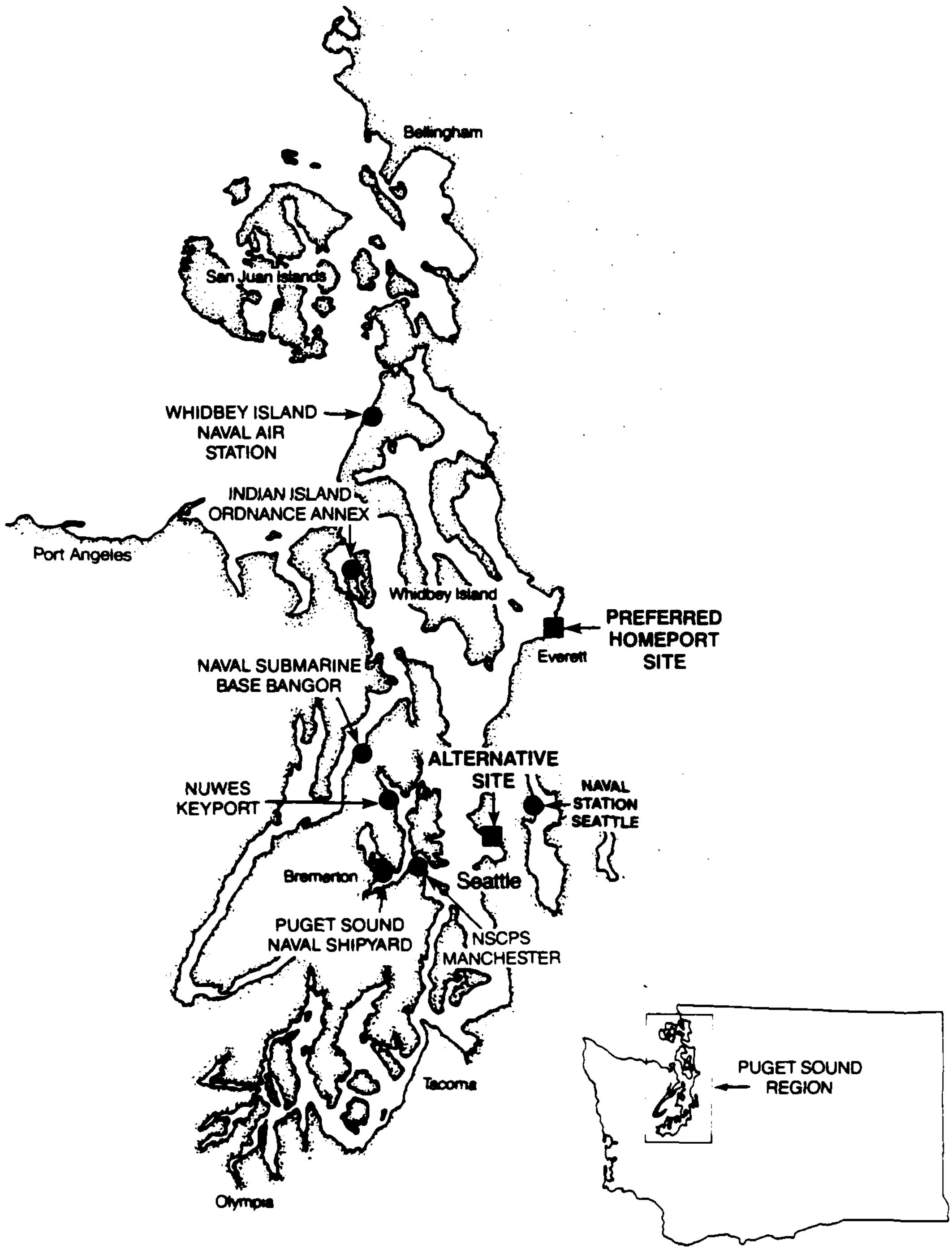
The jurisdiction of the U.S. Army Corps of Engineers for the discharge of dredged or fill material in the proposed area of development includes those areas waterward of the high tide line (National Ocean Survey) and adjacent wetlands. For all other work in the proposed area of development, the jurisdiction of the U.S. Army Corps of Engineers is confined to those areas waterward of the mean high water line (National Ocean Survey). The decision by the U.S. Army Corps of Engineers on whether to issue, deny, or add conditions to the requested permit will be based in part on information in this document.

1.3 Purpose and Need for Project

The Navy is currently committed to the establishment of a 600 ship Navy and to decentralization of future combatant forces. The 600 ship Navy is considered the smallest number of ships that should be maintained to carry out vital national and global defense and to provide the necessary maritime ability and flexibility to meet U.S. worldwide commitments with prudent risk. The Navy now maintains 13 battle groups and is expanding to a program of 15 battle groups strategically stationed worldwide.

The Puget Sound area is proposed to homeport a Naval Carrier Battle Group (CVBG) as a result of the expansion and decentralization program discussed above. Puget Sound provides the Navy with an established Naval support complex, protected deep waterways, and existing industrial, commercial, and transportation networks. All these things are vital to the establishment of Naval station.

As shown in Figures 1-1 and 1-4, the proposed action affects the Puget Sound region of western Washington, an area with an already strong Naval presence. Seven major Navy installations are present in the Puget Sound region, including the Whidbey Island Naval Air Station (NAS), Indian Island Ordnance Annex, Naval Supply Center Puget Sound Manchester, Naval Submarine Base Bangor



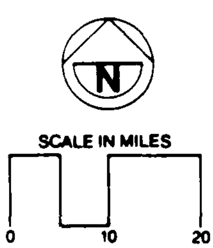


Figure 1-4.
Regional map.

(SUBASE Bangor), Naval Undersea Warfare Engineering Station (NUWES) at Keyport, the Puget Sound Naval Shipyard (PSNS) in Bremerton, and Naval Station Seattle at Sand Point. The deep waters in sheltered inlets and embayments provide numerous natural harbors and have contributed to the development of the various naval facilities in Puget Sound.

In November 1984 a Draft Environmental Impact Statement (DEIS) entitled Carrier Battle Group (CVBG) Homeporting in the Puget Sound Area, Washington State was distributed by the U.S. Department of the Navy, Western Division, Naval Facilities Engineering Command. The study was prepared under the requirements of the National Environmental Policy Act (NEPA) of 1969, the Council on Environmental Quality (CEQ) regulations issued November 29, 1978, and the Navy's regulations for compliance with NEPA (OPNAVINST 5090.1) dated May 26, 1983. The DEIS evaluated two project alternatives and a no action alternative in detail. The two project alternatives included siting a carrier battle group at either Everett (Norton Avenue Terminal) or Seattle (Piers 90 and 91). Both project alternatives had support facilities located at Naval Station Seattle. The Everett homeport site alternative was identified as the Preferred Alternative. Following a review and comment period and a public hearing, a Final Environmental Impact Statement (FEIS) was issued in June 1985. On 27 August 1985, the Secretary of the Navy issued his Record of Decision (ROD) on the FEIS and formally selected Everett as the Preferred Alternative Site for a Carrier Battle Group in Puget Sound.

When the Navy submitted a permit application for dredging and construction of structures in navigable waters to the U.S. Army Corps of Engineers in September 1985, the Corps determined that additional information about the proposed project was needed before a permit decision could be made and that an Environmental Impact Statement Supplement (EISS) would be required. Subjects to be included in the EISS are outlined in the Preface to this document.

1.4. Listing of Studies

Since completion of the Navy FEIS additional environmental and engineering studies have been undertaken by the Navy. Some of these studies address the following topics:

- Homeport master plan
- Homeport soils analysis
- Air quality modeling
- Slope enhancement for fisheries
- Seabird survey
- Crab surveys
- CAD site benthic analysis
- Sediment sampling and analysis
- Characterization of East Waterway sediments

- Water column chemistry
- Physical model of East Waterway
- Confined aquatic disposal (CAD) feasibility
- Dredging equipment evaluation
- Geotechnical characterization of deep delta CAD site
- Alternative dredge disposal site engineering feasibility
- Port Gardner bathymetric survey
- Port Gardner current measurements
- Leachate/sediment settlement tests
- Dump modeling
- Navigational plans for accurate sediment placement
- Construction/post-construction a CAD site monitoring plan

1.5. The U.S. Army Corps of Engineers - Potential Actions and the Public Interest

There are three actions available to the U.S. Army Corps of Engineers in response to the sponsor's application for Section 404 (disposal of dredged and fill materials in waters of the United States) and Section 10 (construction in navigable waters of the United States) permits. These actions are (1) issue permit, (2) deny permit, and (3) issue permit with conditions. If the permit is issued, the impacts identified in Section 4 of this document would occur. If the permit is denied, all impacts identified under the no-action alternative (see Navy FEIS) would occur. Under the third possible action, the U.S. Army Corps of Engineers could issue a permit with special conditions intended to mitigate adverse impacts in accordance with 33 CFR 325.4.

The decision by the U.S. Army Corps of Engineers whether to issue a permit for the proposed project will be based on the evaluation of probable impacts of the proposed project on the public interest. All factors relevant to the public interest for the project must be considered and the benefits weighed against the detriments. U.S. Army Corps of Engineers regulations for permit evaluation indicate that a decision on permit issuance should reflect the concern for both protection and use of important resources. Factors of the public interest include: conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, flood hazards, fish and wildlife values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, and, in general, the needs and welfare of the people.

The following general criteria are considered in the evaluation of every permit application:

1. The relative extent of public and private need for the proposed structure or project.

2. Where there are unresolved conflicts as to resource use, the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed structure or work.

3. The extent and permanence of the beneficial and/or detrimental effects which the proposed structure or work may have on the public and private uses to which the area is suited.

1.6. Summary of Alternatives Evaluated

The alternatives whose environmental effects and public interest factors the U.S. Army Corps of Engineers must compare with those of the proposed action include: no action, alternative homeport sites, alternative dredging methods, and alternative dredge disposal methods.

In order to implement the Navy's strategic homeporting concept a siting analysis was conducted in the Puget Sound region. The analysis was based on the feasibility of locating a carrier battle group composed of 15 ships that would function as an operational unit.

A total of ten locations were identified as possible sites for all or a portion of the carrier battle group. The study locations included:

Bangor (SUBASE)	Port Angeles
Bellingham (Cherry Point)	Whidbey Island (NAS)
Bremerton (PSNS)	Seattle
Mukilteo	Tacoma
Olympia	Everett

Each of the locations was evaluated from the perspective of homeporting the entire carrier battle group, but also as a homeport for a part of the ships (i.e., split siting). In total, twenty-one single and combined locations were analyzed during three separate studies.

Each location was evaluated in terms of operational capability, cost, location, land area, land availability, community impact, community acceptance, and proximity to Puget Sound, Ship Overhaul/Selected Restricted Availability. Based on these criteria, the Everett site was selected as the preferred homeport alternative.

Eight disposal sites were evaluated in terms of potential environmental impacts, engineering feasibility, dredging methods, and cost considerations. Two additional disposal sites, one situated in 300 to 370 feet of water, the other in 310 to 430

feet of water were also viewed as alternatives for confined aquatic disposal.

Based on the site evaluation and resource agency concerns regarding Dungeness crab resources, the site located approximately 1.3 nautical miles southwest of the proposed homeport, in 310 to 430 feet of water, was developed as the preferred disposal site alternative (RAD CAD). The disposal operation would use clean sediments from East Waterway to encapsulate, or cap, contaminated dredge material.

A variety of dredging and disposal methods were evaluated for both the contaminated and clean sediments in concert with assessment of disposal sites. Studies at the CAD site determined that the most suitable method of dredging the contaminated material will be to use a clamshell dredge so that sediments will have minimum contact with the water column. The contaminated material will then be transported to the disposal site by barge and bottom dumped. The clean material will be dredged using either a clam shell or hydraulic dredge and transported to the disposal site by a pipeline or pumpout barge.

1.7. Adverse and Beneficial Impacts and Mitigating Measures Discussed in this EISS

The following paragraphs are not intended as a summary of all impacts associated with the homeporting project. The intention is to summarize only the impacts described in this EIS Supplement. Detailed discussions of other project impacts can be reviewed in the Navy FEIS.

Dredging/Dredge Disposal

- Impacts from dredging and dredge disposal are summarized in the following water quality and fisheries sections.

Water Quality

- Dredge and disposal impacts of the proposed project would result in the release of various contaminants to the water column. Based on a recent laboratory studies with East Waterway sediments, water column concentrations (total and dissolved) of contaminants of concern are expected to be below U.S. EPA water quality criteria established for the protection of aquatic life. Mass release of sediment bound contaminated particles to the water column of Puget Sound would also occur. Such releases would result in the temporary spread of contaminants from the East Waterway during dredge and disposal activities. Because of the temporary and intermittent nature of these activities,

impacts would also be temporary. Given adequate dilution, water quality impacts are anticipated to be minor.

- The project may result in the discharge of graywater to East Waterway from four of 15 ships berthed at the homeport. Adverse water quality impacts would be minor for the East Waterway as a whole, but may result in elevated levels of copper in quay areas adjacent to these discharges.

- The use of organotin in antifouling paints on ship hulls could result in adverse impacts to water quality or to aquatic biota of East Waterway as a whole. Areas adjacent to ships may experience somewhat elevated concentrations of organotin resulting in impairment to localized biological communities. However, the Navy's commitment to use an approved TBT paint formulation will ensure that adverse impacts do not occur through the use of TBT. The Navy is not committed to conduct TBT monitoring in East Waterway.

- Oil spills at the proposed facility may be expected to adversely impact water quality and related biota. Precautionary measures are anticipated to minimize the frequency and occurrence of such events.

- Cumulative impacts of project construction are primarily associated with dredge and dredge disposal activities. Additional dredging for Port of Everett facilities will require that approximately 6 percent (51,500 cubic yards) more contaminated material be dredged and disposed of. The cumulative water quality and biota impacts of such activities are not expected to measurably increase beyond those predicted for the Navy homeport dredging and disposal activities. Cumulative impacts of operation, while difficult to quantify, will be related to the additive effects of oil spills, graywater discharges, organotin paint, and other, as yet, unforeseen operational activities. Degraded water quality could occur as a result of these activities. However, cumulative impacts of operation are expected to be minor for reasons discussed in the text.

<u>Fisheries Resources</u>

- Adult Dungeness crab would be impacted to some degree by disposal at either of the three Confined Aquatic Disposal (CAD) sites. The primary short-term impact would be due to burial, physical trauma or associated stress that would result from barge dumping of berm and

contaminated materials. At the three alternative sites identified, this impact in a conservative analysis would kill about 15,000 female crabs at DD CAD, 990 females at SW CAD, and 800 females at RAD CAD. Some male crabs would also be killed, however, few occur at the depths of these sites. Prior to capping, some female crabs would be exposed to the same contaminated material that males are presently exposed to in the East Waterway. Contaminated material would be capped prior to the time females bear eggs, thereby preventing toxic impacts in the reproductive life stage. Recolonization of any of the three CAD sites would begin immediately following cessation of capping activities in each of the two years. Substantial recovery would have occurred between FY 87 and FY 88. However, additional cap placed in FY 88 would destroy this recovery. By late spring to summer of 1989, the site would be repopulated by many, if not most, of the existing species of macroinvertebrates with population numbers approaching existing levels. The cap material has been shown to have grain size distribution characteristics similar to those at the existing site. Thus, long-term productivity of any of the CAD sites would be expected to be similar.

- The majority of the juvenile salmonid population will be protected from adverse affects of dredging as dredging will not occur from March 15 to June 15, encompassing the period of major juvenile salmonid outmigration. No in-water construction work (with the exception of pile tests), including dredging, will occur during this time period. It has been documented that juvenile salmonids are present in the East Waterway vicinity after June 15 (Navy FEIS, Appendix C; Tulalip Tribes, 1986). Dredging impacts to fish present after June 15 will be minimized due to their pelagic nature and the fact that they are of sufficient size to avoid the majority of the impacts.

- Juvenile Dungeness crab survival may decrease in the East Waterway due to alteration of preferred habitat. Not enough information is known about juvenile crab habitat requirements to quantify any decrease in survival, but it is anticipated that the proposed shoreline habitat is not as suitable as what presently exists due to the absence of bark that provides cover for the young crabs.

- A temporary loss of benthic and epibenthic production will occur in the East Waterway during dredging operations. This loss will have a temporary effect on demersal fish and adult crab production in that area.

The clean sediments that will be present following the dredging operation will support more diverse and abundant benthic and epibenthic communities at least in the short term which in turn will provide better habitat for demersal fish and crab production. This may provide a long-term improvement in the area if upland sources of the pollutants are removed.

Air Quality

- Traffic related emissions consist of carbon monoxide (CO), oxides of nitrogen (NO_x), and hydrocarbons (HC). Modeling estimates of CO emissions (the pollutant of primary interest for mobile sources) predicted that concentrations would be below the standards set by EPA.

- Non-traffic related emissions of NO_x would be slightly higher than the level considered significant by the EPA, but still far below the set standard.

Threatened and Endangered Species

- Neither project construction nor operation are expected to result in long-term detrimental changes in the use of the area by threatened or endangered species.

- Biological assessments have been prepared and submitted to the U.S. Fish and Wildlife Service and National Marine Fisheries Service. Review of one assessment by the National Marine Fisheries Service concluded that there will be no impact to Federally listed marine animals. The second assessment, for bald eagles, concludes that the project will not result in any permanent habitual use changes in the area by bald eagles. This assessment is presently being reviewed by USFWS.

Soils and Geology

- The project site is located in a seismically active area. A maximum credible event of magnitude 7.5 on the Richter scale has been predicted for the area, with a recurrence rate of 500 to 2500 years and a peak firm ground acceleration of 0.15g.

- Evaluation of historical data shows that the probability of occurrence of mass wasting is low due to the low sedimentation rates in the delta. Placement of the mound of uncontaminated materials downslope of the contaminated materials will reduce the likelihood of spreading of contaminated materials due to flow slides during placement or seismic events. This will be

further considered in the design and placement of the mound.

- The liquefaction assessment of project site soils indicated that soils in the upper 60 to 80 feet may liquefy at acceleration levels equal to or greater than 0.1 g. Liquefaction can result in limited vertical or horizontal displacements, loss of foundation support, slope failure, and/or settlement. Design of the facilities considered earthquake impacts, including the potential for and intensity of ground shaking, ground rupture due to faulting, liquefaction, and ground displacement due to land sliding.

Native American Concerns

- Impacts to usual and accustomed fishing areas, fishing activities, and land use were previously identified in the Navy FEIS. Information gained since the Navy's FEIS (crabs and demersal fish) is included in this document. Impacts on water quality and fisheries resources resulting from dredging and dredge disposal are also discussed in greater detail in Chapter 8 as well as information on treaty tribes and trust responsibilities. A memorandum of agreement is presently being negotiated by the Navy and the Tulalip Tribes.

Traffic and Transportation

- During periods of highest activity approximately 20,800 daily vehicle trips could be generated by the proposed homeport.

- Level of service (LOS) could drop from LOS A (free flow) to LOS C (reduced speeds) or lower, depending on the access route design selected for West Marine View Drive.

- Increased vehicular traffic would result in a greater number of accidents and slower emergency vehicle response times.

Population and Housing

- Homeporting would stimulate growth in Snohomish County initially as a result of base construction and later, more significantly, as a result of operation of the base. The operational phase of homeporting would increase employment in Snohomish County by approximately 16,000 jobs in 1992 and would cause an estimated population increase of about 27,100 people by 1992.

- Homeporting will result in a significant demand for housing in the Everett/Snohomish County area. The Navy does not intend to provide housing for the new population but will rely on the local private real estate development community to meet the increased housing demand. Of the estimated 3,161 Navy families associated with homeport operations, 64 percent (2,031) are expected to rent their homes with the remainder expected to own their homes.

- Homeporting is expected to stimulate commercial growth in downtown Everett, and to a lesser extent, in south Snohomish County.

- No significant impacts would occur on University of Washington housing adjacent to Naval Station Seattle as a result of homeporting.

Port of Everett Relocation Activities

- 117 acres of land owned by the Port of Everett would be purchased for the homeport base. Current uses that would be displaced by the homeporting project include a chill facility for the storage of perishables, a large graveled laydown area, several small general use structures, a manufacturing plant operated by Western Gear Corporation, and piers used for log loading and handling of other commodities.

- If Western Gear Corporation relocated out of the area 350 jobs as well as tax revenues associated with the firms operations would be lost to the local economy.

Social Services

- No adverse impacts on local hospital services and facilities is expected. Health care is provided by the government for Navy personnel and their departments. In other cases user fees and/or revenue bonds finance most hospital services and facilities.

- For the various social service agencies the Navy-related increase in clients served would range between five and seven percent while staff increases required to handle the rise in caseload would range from one-half to five percent.

Public Services

- The sanitary waste water demand at the City of Everett treatment facility resulting from base operations and

direct and indirect population increases will be about 1.45 MGD.

- The City is considering the upgrade and expansion of their sewage treatment facility. Under the planned expansion sufficient capacity would exist to handle Navy-related flows.

- Impacts on schools as a result of homeporting are not expected to be generally significant. The Everett School District will experience a greater impact than other school districts. For the Everett School District a Navy-related deficit of about $54,000 will occur in 1994-95, which represents about 12 percent of the overall expected deficit for one school district.

- Local governments will experience a Navy-related deficit which in the steady-state condition (1994 and after) will constitute from three percent (City of Mukilteo) to twenty percent (City of Everett) of their expected overall operating deficit.

- Snohomish County Fire Districts 12, 15, and 21 are expected to require capital outlay of significant operating expenditures as a result of homeporting.

- Flows from the homeporting facility may generate higher than normal levels of hydrogen sulfide as a result of holding anaerobic blackwater aboard ships. This may result in the potential for corrosion in sewage system piping. If this occurs pre-treatment of flows from the base would be necessary.

Nuclear Concerns

- The Naval Nuclear Propulsion Program provides comprehensive technical management of all aspects of Naval nuclear propulsion plant design, construction and operation including careful consideration of reactor safety, radiological, environmental, and emergency planning concerns. The record of the Program's environmental and radiological performance at the operating bases and shipyards presently utilized by nuclear powered warships demonstrates the continued effectiveness of this management philosophy. It further demonstrates that application of the environmental practices which are standard throughout the Program will assure the absence of any adverse radiological environmental effect at the Everett, Washington homeport site. Local and state agencies are responsible for evacuation plans.

2. SITING ANALYSIS AND PROJECT DESCRIPTION

2.1. Siting Analysis

In order to implement the Navy's strategic homeporting concept a detailed siting analysis was conducted in the Puget Sound region. The analysis was based on the feasibility of locating a carrier battle group composed of 15 ships that would function as an operational unit.

A total of ten locations were identified as possible sites for all or a portion of the carrier battle group. The study locations included:

Bangor (SUBASE)	Port Angeles
Bellingham (Cherry Point)	Seattle
Bremerton (PSNS)	Tacoma
Mukilteo	Whidbey Island (NAS)
Olympia	Everett

Not only were each of the locations evaluated from the perspective of homeporting the entire carrier battle group, but also as a homeport for a part of the ships (i.e., split siting). In total, twenty-one single and combined locations were analyzed during three separate studies.

The three siting studies were evolutionary in that as each additional study was undertaken the scope of the carrier battle group became more refined and the siting criteria could then be applied more stringently. Consequently, the first study was a feasibility/capability analysis for locating a carrier battle group of undefined size. The study developed generic siting requirements for a carrier battle group of up to 20 ships such as distances for berthing, ordnance arcs, space requirements, and a rough estimate of personnel numbers. The second siting analysis assessed a larger number of potential sites using a refinement of the siting criteria and included factors such as operational capability and cost. More sites and site combinations were added to the second analysis. The third siting review was based on the requirements for a specific carrier battle group size and ship mix. Because more detailed information was developed for personnel strength, functions of the homeport, basic facility requirements, and cost factors, the siting criteria could be applied more thoroughly and in a comparative manner to each of the potential sites. Some additional site combinations were also added to the analysis.

The possible homeport locations were evaluated in terms of:

- Operational Capability - factors affecting battle group support and deployability;

- Cost - comparison of cost factors that would vary from site to site;

- Location - assessed with respect to distance to existing installations and facilities as well as transit time to open sea;

- Land Area - consideration of amount of developable waterfront land and adjacent/remote land relative to homeport requirements;

- Land Availability - assessment of the likelihood that land could be acquired in a suitable timeframe;

- Community Impact - estimation of the relative capability of the community to absorb the battle group personnel using population, housing, and school capacity data;

- Community Acceptance - a subjective appraisal of the community's support of the homeport derived from discussions with business leaders, elected officials, citizen groups, and the general public;

- Proximity to Puget Sound Ship Overhaul/Selected Restricted Availability (SRA) Yards - a factor appraised with respect to the location of repair facilities and the need for permanent change of station (PCS) move requirements of personnel when major overhauls take place.

Environmental factors were not considered in detail for those sites that could not meet minimum strategic and logistic criteria. Several split site alternatives were carried throughout the siting analysis even though there were a number of concerns about using more than one location for homeporting. Generally, split site alternatives were less desireable because of the need for redundant facilities, a more complex organizational structure, and higher operational costs. Table 2-1 presents a matrix summarizing the homeport siting analysis. The matrix was developed from available data.

Four of the locations were dropped from further consideration principally because of a lack of waterfront land to support a portion of the carrier battle group as well as for the following reasons:

- Port Angeles - The area is isolated from many services and the socioeconomic impacts would be great because of the city's relatively small size.

Table 2-1. Site Analysis Matrix.

	Land Area	Operational Capability	Preliminary Construction Cost (millions)	Location	Community Impacts	Overhaul/SRA Proximity	Environmental Considerations
Bangor	Marginal	Not acceptable	\$350-\$375	Acceptable	High	Not acceptable	Loss of shellfish
Bellingham	Adequate land	Preferable	over \$500	Not acceptable	High	Not acceptable	Loss of eelgrass beds and herring spawning habitat; Native American concerns
Bremerton	Inadequate-would impact PSNS and community	Not acceptable	\$375-\$400	Preferable	High	Preferable	Loss of intertidal habitat; 500 houses; dredging impacts
Everett	Adequate with off base support	Preferable	\$300-325	Preferable	Moderate	Preferable	Movement of contaminated dredge materials; Native American concerns; crab impacts
Mukilteo	Inadequate to support minimal operations						
Olympia	Inadequate to support minimal operations						
Port Angeles	Inadequate to support minimal operations						
Seattle (90-91)	Adequate with off base support	Preferable	\$300-\$325	Preferable	Moderate	Preferable	Alteration of marine habitat due to dredging; Native American concerns; underwater park impacts
Seattle (new pier)	Adequate with off base support	Preferable	\$350-\$400	Preferable	Moderate	Preferable	Same as above and impacts of pier construction
Tacoma	Inadequate to support						
Whidbey Island	Adequate	Preferable	\$400-\$450	Not acceptable	High	Not acceptable	Significant disruption of intertidal habitat, especially shellfish beds
Bangor/ Bremerton	Marginal--would impact PSNS operations	Not acceptable	\$375-\$400	NA[1]	High	NA	NA[1]

NA[1]--Not applicable because split sites were not operationally acceptable.

Table 2-1. Site Analysis Matrix (cont.).

	Land Area	Operational Capability	Preliminary Construction Cost	Location	Community Impacts	Overhaul/SRA Proximity	Environmental Considerations
Bellingham/ Bremerton	Marginal--would impact PSNS operations	Not acceptable	Over $500	NA	High	NA	NA
Everett/ Bremerton	Marginal--would impact PSNS operations	Not acceptable	$325-$350	NA	Moderate	NA	NA
Everett/ Seattle/ Bremerton	Marginal--would impact PSNS operations	Not acceptable	$375-$400	NA	Moderate	NA	NA
Seattle/ Everett	Adequate	Not acceptable	$375-$400	NA	Moderate	NA	NA
Seattle/ Bremerton	Marginal--would impact PSNS operations	Not acceptable	$350-$375	NA	Moderate	NA	NA
Seattle/ Whidbey	Adequate	Not acceptable	$450-$500	NA	High	NA	NA
Whidbey/ Bremerton	Marginal--would impact PSNS operations	Not acceptable	$450-$500	NA	High	NA	NA

- Mukilteo - The lack of available waterfront land precluded further evaluation.

- Tacoma - There is restricted ship maneuverability in the port area and a comparatively long trip to open ocean.

- Olympia - There are shallow water problems and a very long transit to open ocean.

A site was reviewed in the Cherry Point area near Bellingham for a homeport. A substantial amount of land is available to support the development of a homeport; however, a number of other criteria made the site less favorable. For example, it would be very costly to develop the site because of extensive dredging and breakwater requirements, as well as related environmental concerns especially valuable eelgrass beds and herring spawning habitat. Community impacts would be very high because of the small population, lack of housing supply, and inadequate school capacity. Another negative factor was the distance from major ship repair facilities at Puget Sound Naval Shipyard and the commercial shipyards in Seattle, necessitating permanent change of station moves for personnel when overhauls took place. Very preliminary construction cost estimates indicated that development of a homeport at Bellingham would cost about 250 million dollars more than the Everett alternative. Bellingham was also considered a split site alternative with a portion of the battle group at Puget Sound Naval Shipyard; however, the costs of this alternative were at least 60 percent higher than the Everett alternative.

Naval Air Station (NAS) Whidbey Island was also evaluated as a potential homeport for the entire carrier battle group. Some of the desirable aspects of this location included the fact that operations would be co-located with the naval air station and that there is quick, direct access to open ocean. Sufficient waterfront land was available to accommodate base requirements, and joint use of NAS Whidbey Island existing facilities would provide some cost savings. Since the site is NAS property, it would be readily available. However, the site would be very expensive to develop because of dredging and construction problems as well as disruption of intertidal habitat. Construction of the mole pier-breakwater would cause environmental disruption of a state "natural conservancy shoreline." The cost of developing a homeport at NAS Whidbey Island as a single site ranked third highest of all sites considered. Furthermore, a carrier battle group would double the island population, with significant impacts on housing, schools, and other services. As was the case with Bellingham, distance from ship repair facilities would make it necessary to make a permanent change of station for personnel when a ship was being

overhauled. Remoteness from other naval installations would also make operational logistics complicated.

NAS Whidbey Island was also considered as part of a split site alternative, with a part of the battle group stationed at Puget Sound Naval Shipyard. Although some of the community impacts would be lessened by this alternative, problems of high cost, relative isolation and environmental issues would still remain.

SUBASE Bangor was rated as a site for both the entire homeport and as part of a split site with Puget Sound Naval Shipyard. Operational considerations such as poor logistics and distance from industrial support made the site undesirable. Community impacts, especially for siting of the entire battle group, were considered to be unacceptably high.

Puget Sound Naval Shipyard (PSNS), located in Bremerton, was evaluated both as a site for development as a homeport for the entire carrier battle group as well as for partial stationing of ships with the remainder of the carrier battle group locating at either Seattle or Everett in addition to the sites mentioned above. A major constraint was the fact that the primary mission of PSNS is ship maintenance and repair and that role must be preserved. There is not room at PSNS to homeport the entire battle group and still carry out its shipyard mission. At least one pier that might be used for berthing would require substantial reconstruction, and Fleet Reserve moorings are inadequate for active ships because of their narrowness and lack of cold iron (utility) facilities. Nevertheless, a scenario was developed in which the carrier battle group would occupy principally the southern portion of the shipyard, the mothball fleet would be relocated, several existing piers would be demolished and replaced and a mole and quaywall would be constructed along State Route 3.

PSNS land and facilities for training, logistics, and support are already overburdened. Presently, there is virtually no waterfront land to support development of a homeport at PSNS, and substantial filling to create land would be required. Additionally, State Route 3 would need to be rerouted so that upland facilities would be contiguous to the remainder of the homeport and roughly 500 homes would have to be acquired to provide space for location of support facilities. Since homes near PSNS have a very high occupancy rate, the relocation impacts would be severe. Individual ownership of such a large number of houses would make it difficult and time consuming to acquire property. Homeporting of the battle group at PSNS would increase the population of the Bremerton area by roughly 50 percent, causing significant negative impacts on housing and community services. In addition to adverse environmental impacts, preliminary construction cost estimates indicated that development of a homeport at Bremerton

would be more than 300 million dollars higher than at Everett when offsite impacts are taken into consideration.

Even if land was available, there are a number of operational constraints associated with homeporting at Bremerton including the fact that entry and exit into Bremerton through Rich Passage is somewhat arduous, primarily due to the narrow channel and the sharp turn at Point Glover. Presently carriers and other deep draft vessels are brought through primarily at slack high tide because of the strong tides and a minus 41 foot sandbar opposite the turn. Congestion resulting from frequent movement of smaller ships, including the Washington State ferries is also a cause for concern.

Many of the same factors apply to a partial, or split, homeporting of the carrier battle group between Bremerton and another location. The issue of scarcity of developable land would still exist, but on a smaller scale, as would community impacts. Navigational safety in Rich Passage would still be a major concern. Impacts to PSNS operations would still occur, but to a lesser extent. Some of the same construction and dredging and fill problems and related environmental impacts would still exist. According to preliminary construction cost estimates, a split site between Everett and Bremerton (the least expensive of the split site alternatives) would be about 25 million dollars higher than the Everett alternative. Operational costs associated with the logistics of a split site alternative would be higher than for a single site alternative because of the need for redundant facilities and personnel. NAS Whidbey Island, Seattle, Everett, Seattle and Everett, and Bangor were all assessed as split site alternatives with PSNS. Preliminary construction cost estimates for split site alternatives ranged from about 25 to 140 million dollars higher than the Everett alternative.

Several Seattle alternatives were considered, including a base using Piers 90 and 91, a base using Pier 90 and an extended Pier 91, a base using Pier 91 and a new adjacent floating Pier 92, a split site with PSNS, a split site with NAS Whidbey Island, and a split site with Everett. All of the alternatives except a base at Piers 90 and 91 were rejected because of high construction and/or operations costs.

The Pier 90 and 91 alternative was desirable because the site could adequately support battle group operations, cost of development was relatively low, and there was adequate community infrastructure in the area. Furthermore, the site is close to overhaul yards so that PCS moves would not be necessary and industrial support facilities are nearby. Major negative aspects of the site were the lack of contiguous buildable land area for all support facilities and physical security concerns.

Everett was also evaluated under several homeporting scenarios, including locating the entire carrier battle group there and split homeporting with Seattle, PSNS, and a Seattle and PSNS combination. Again, the split site alternatives were considered to cost more than a single site alternative and present operational and logistical difficulties.

Positive aspects of the Everett alternative were that the site would adequately support battle group operations, relatively low cost, comparatively moderate community impacts and proximity to ship overhaul and support industrial services. Land was also considered to be relatively available for purchase. It would be easy to disperse ships from Everett, since there are no bridges to block access to sea and no narrow channels to bottle up the battle group. Overall, Everett best meets all of the homeport site selection criteria of the many alternatives evaluated. Negative aspects of the alternative were that the site does not satisfy all land requirements at one location and that some services would have to situated off site.

Although preliminary construction cost estimates indicated that the Seattle Terminal 90-91 alternative was about 4 million dollars less than the Everett alternative, it had 23 fewer acres of waterfront land available for facility development. This factor, in addition to environmental impacts such as traffic congestion and lack of community acceptance, as well as availability of land for purchase, led to the selection of Everett as the preferred homeport alternative.

2.2. Project Description

As a result of the scoping process conducted by the U.S. Army Corps of Engineers it was determined that additional information about the Preferred Alternative, homeporting a carrier vessel battle group at Everett, was necessary to make a decision on the Section 10/404 permit. The information contained in this section, where appropriate, updates the project description for the Preferred Alternative.

During development of the draft and final environmental impact statements for the proposed homeporting project, an estimate of 15 ships was used in the assessment of conservative impacts. The 15 ships are a Navy long range estimate of the maximum number of vessels to be stationed at the homeport. During the initial phase of the proposed project, through 1992, the Navy plans to homeport 13 ships. Consequently, the scenarios used for much of the impact analysis represent a larger carrier battle group than is presently planned.

Operation of a carrier battle group homeport at the Everett site would require construction or rehabilitation of existing facilities to accommodate the following 15 ships:

Type of Ship	Number of Ships	Approximate Draft (in feet)
o Carrier (CVN)	1	41
o Guided Missile Cruiser (CG)	2	29
o Guided Missile Nuclear Cruiser (CGN)	2	31
o Destroyer (DD)	2	32
o Guided Missile Destroyer (DDG)	2	34
o Guided Missile Frigate (FFG)	4 (2NRF)	25
o Mine Countermeasures Ship (MCM)	2 (NRF)	12
Total Ships	15	

As shown above, four of the fifteen ships would be Naval Reserve Forces (NRF) ships and would operate independently of the main Battle Group, which would consist of the carrier and ten combatants. One additional ship, a Destroyer Tender (AD) would spend a maximum of one month per quarter at the homeport. Two fast combat support ships (AOE's) which are currently homeported at the Puget Sound Naval Shipyard (PSNS) in Bremerton would participate in some battle group activities but would remain homeported at PSNS.

Small service craft assigned to the Everett waterfront would require approximately 1,100 feet of berthing. There would be up to 10 vessels of this type that would be either owned by the Navy or commercial firms. Support craft assigned to the waterfront for a 15 vessel carrier battle group would include the following:

Description	Type	Quantity
Tug Boats (large	YTB	2
Mark II Personnel Boat	LCPL	1
Pusher Boats	LCM	2
Pusher Boats	WB50	2
Oily Waste Barge	SWOB	1

In addition, there would be two to seven service craft leased to the Navy.

Small service craft would be maintained by the Port Operations office, which schedules, coordinates, and assigns watercraft to

assist fleet units. In addition, the Port Services office keeps harbor (waterfront) facilities clear of obstructions, assists all vessels while in port, and, if necessary, patrols and maintains the security of the harbor.

2.2.1. Shoreside Facilities

Location of a homeport facility at the Norton Avenue Terminal site, comprising 117 acres, in Everett would require construction of a number of support facilities. The existing facilities located at the Norton Avenue Terminal site are shown on Figure 1-3. Figure 2-1 shows a the draft design concept of how the facilities would be arranged at the proposed homeport. Functionally, the homeport would be divided into three land use zones, a waterfront zone, an industrial and supply support zone, and a station and personnel support zone. In addition to factors such as functional efficiency and engineering feasibility, the site layout and location of facilities also considered operational criteria such as explosive safety quantity distance (ESQD) arcs around ships required for frequently ordnance handling.

2.2.1.1. Waterfront Zone

The waterfront zone contains a breakwater, a pier, wharfs, and utilities for ship berthing. Also included are laydown areas at shoreside, parking, roadways, connecting utilities, the shore utilities building, walkways, a collimination tower, and a helicopter landing area.

The berthing plan for the proposed homeport calls for a 1,600 foot long carrier pier, a south marginal wharf having 325 and 750 foot long berthing areas, and a 2,100 foot long central marginal wharf. A future (not programmed at this time) north marginal wharf having 700 to 900 feet of berthing can be located along the harbor's north shore.

The length of the carrier pier, 1,600 feet, is determined by the berthing requirements of the two cruisers (1,485 feet) and a causeway extension to the shore to accommodate the mole slope. The south marginal wharf's length is determined by the length of the visiting destroyer tender. The 325 foot mine countermeasure berth on the south marginal wharf is the minimum length required for that ship. The 2,100 foot long central marginal wharf provides required clearances between the destroyers and frigates. It also provides clearance between the ships that could be located at a north marginal wharf if one was to be constructed in the future. Tug assistance would be required to maneuver the ships into their berths.

A 1,600 linear foot rubble-mound breakwater would be constructed to protect the carrier pier from the northwest and western exposure. The breakwater will also divert sediment carried by

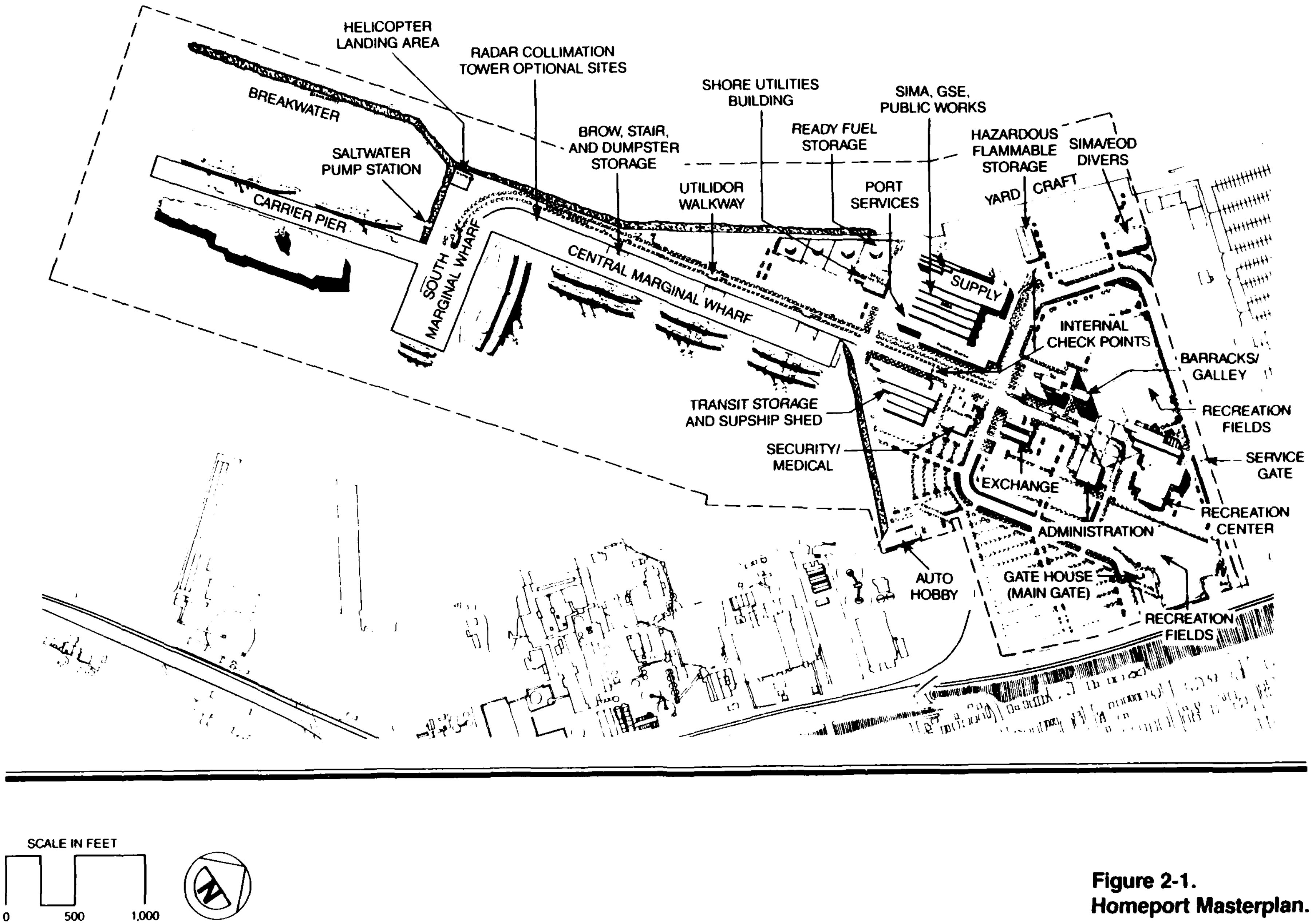


Figure 2-1.
Homeport Masterplan.

the Snohomish River past the naval facility into deeper water. The crest of the breakwater would be at +15 feet mean low water (MLLW). A gap would be left in the breakwater to allow for a more direct passage of fish into the East Waterway. The breakwater would provide storm protection to a greater extent of Port of Everett shoreline on the east side of the East Waterway than is presently the case.

2.2.1.2. Industrial and Supply Zone

Most of the industrial and supply functions will be collocated in the main industrial complex. This is a split-level one and two-story building that will house the Shore Intermediate Maintenance Activity (SIMA), most of the homeport's general warehouse, a ground support equipment (GSE) shop and shed, public works shops and storage, port services offices and control tower, SERVMART, a mobile training unit (MOTU), and a freeze/chill facility. During predeployment activities, the industrial complex would ship and receive between 30 and 50 truckloads of material in a day.

The SIMA is the largest building in the main complex. It will have a single-story high-bay construction of approximately 135,000 square feet. Its function is to house facilities for intermediate-level maintenance of both active ships and reserve ships and to provide training for Naval Reserve personnel in maintenance. It would also contain a limited MOTU for the ships. Special equipment and facilities will include overhead bridge cranes, industrial and oily waste control systems and specialized repair areas.

The supply functions would be grouped in a high-bay structure on the west side of the main complex near the barge terminal and away from the main axis. Its functions will consist of general storage, SERVMART, the chill/freeze facility, and an open storage shed.

The port services and public works functions would be located adjacent to the SIMA on its main axis side for convenient access to the berths and the stations shoreside facilities. A major mission of these facilities is to manage the safe berthing of the ships and to provide in-port services such as brows, utility connections, tow services, and facility maintenance. A port control tower would be located on an elevated platform on the port services building. The tower is used to oversee ship and small craft movement within the harbor.

The GSE function would be located in a wing near the loading area of the SIMA building. This single-story structure will house facilities to provide complete maintenance, repair, upkeep, and storage of GSE and ordnance handling from the carrier. The EOD/SIMA dive activities will be housed in the existing chill structure. The facility will contain offices, training rooms,

storage and maintenance area, a hyperbaric chamber, bottle filling equipment, an emergency response locker, and vehicle and boat parking with pull-through capabilities. A transit shed would provide covered storage for carrier transit materials, supervisor of ship building storage, and shoreside material handling and staging.

The ready fuel storage facility would consist of fuel storage tanks and a building for petroleum, oil, and lubricants (POL) sampling, and testing. The facility is located near Norton Terminal for fuel barge access and close to the ships for top-off fueling of the berthed ships. Several sites were analyzed and this site was chosen because of substantially lower foundation costs and proximity to the supply complex. The location of the POL building was selected to be near the fuel tanks and pumps for convenient sampling and testing. The facility has four fuel storage tanks providing storage for a total of 60,000 barrels of diesel fuel marine (DFM) and 40,000 barrels of JP-5 jet fuel. The tanks would be set apart by one tank diameter from each other and 100 feet from the structures. These tanks are surrounded by earthen, diked, enclosures sized to contain the full contents of each tank. Pumps and piping are provided to move fuel from the barges through the tanks and to the berths. Special oil spill containment and control equipment would also be provided at all stages of fuel handling.

2.2.1.3. Station and Personnel Support Zone

This zone is farthest from the waterfront. It contains the barracks/galley, the recreational complex, the location exchange complex, the administration, and security/medical facilities.

The administration building provides for the general administrative functions of the Everett site and for the related activities of legal services, chaplain, training, post office, and motion picture exchange. The security/medical building would house the homeport's police station, fire station, telephone exchange, Naval Communications Center, and medical and dental clinics. The medical and dental clinics would provide out patient health care for ship and station personnel. Retired personnel care would not be provided.

The exchange building would primarily serve active duty personnel stationed at Everett. The facility includes a retail sales area, uniform shop, food service area, laundry, and barber shop. The barracks and galley would be housed in a five to seven story building.

The recreation complex would include a service club, bowling alley, amusement facilities, and sports center. A 25 meter indoor swimming pool and a full-sized gymnasium with seating for 1,000 spectators would be the main features of the sports center.

Approximately 13 acres would be devoted to use as recreation fields. Fleet commands place heavy emphasis on team sports programs to enhance morale and command identity. It is expected that softball, football, soccer, and basketball would be major homeport personnel sports activities. An auto hobby shop would also be included for personnel use.

2.2.2 Personnel

The proposed carrier battle group deployment cycle calls for one-month predeployment operations, six months on cruise, and twelve months assigned to the homeport at Everett. Upon return from the six-month cruise, the ships would enter into a 30-day stand-down period; during this period, approximately 50 percent of the ship's company would be leaving the ship for shore leave, new assignments, schools, training, or would be discharged. Also, during this 30-day period arrangements would be underway to accommodate SRA (Selected Restricted Availability) maintenance by contractors and other support personnel assigned to the ships.

After the stand-down period, some SRA, SIMA, and miscellaneous work would occur. The ships' crew would have returned and would be ready to undergo sea exercises after being in port between 1 1/2 and 4 months, depending on the type of ship and its repairs. The active duty ships assigned to the battle group would spend the next eight to ten months conducting at sea operations approximately twenty to thirty days per quarter. Typical operations include:

- o engine trials
- o operational inspections
- o training exercises
- o other port calls

The four Reserve ships homeported at Everett, consisting of 2 FFG's and 2 MCM's would conduct sea operations/deployment differently, since their crews would contain 60 percent weekend reservists. It is estimated that the reserve ships would deploy for weekend training at least one weekend a month with a nearly full crew. Some limited operations would also be conducted monthly with the assigned active duty crew. Reserve ships would conduct two-week training cruises at least once a year, and these cruises could involve joining active duty training exercises. The historic estimated sea time for Reserve ships indicates that the FFG's would spend 25 percent at sea per quarter and the MCM's 40 percent at sea per quarter.

Preliminary estimates of personnel assigned to the Everett homeport under a 15 ship carrier battle groups scenario are listed in Table 2-2. In general, personnel fluctuations at the homeport site would be directly related to the deployment of the aircraft carrier and the return of the battle group to its

homeport. The maximum number of Naval personnel operating at the homeport would take place approximately 1 to 1 1/2 months prior to deployment of the carrier. At this time, squadron personnel assigned to the carrier air wing, equipment, and personal belongings would be arriving at Everett in preparation for deployment. The air wing, less its air crews, would number approximately 7,300 persons. Shoreside support personnel permanently assigned to the homeport would include about 870 military and 475 civilian employees.

Table 2-2. Estimated personnel assigned to the Homeport (15 ship scenario).

	Officers	Enlisted	Total
Military			
Shipboard	440	6882	7322
Shore Based at Site	31	838	869
Naval Station Seattle	19	72	91
	490	7792	8282
Dependents			
Site	773	6904	7677
Naval Station Seattle	32	70	102
	805	6974	7779
Civilian			
Site	-	-	475
Naval Station Seattle	-	-	220
			695
Civilian Dependents			
Site	-	-	590
Naval Station Seattle	-	-	316
			906

Approximately 50 percent of the military population assigned to ships at the Everett site are expected to reside aboard their ships. An additional 465 personnel assigned to the homeport are expected to reside in the BEQ (Bachelor Enlisted Quarters) on-site. The remainder of the military and all civilian personnel and their dependents are expected to reside elsewhere in the civilian community.

There are only relatively short periods of time when all assigned personnel are expected to be at the homeport. In addition to sea trials, exercises and the six-month deployment, other activities would cause personnel to be away from the base. Annual leave of homeport Naval forces is a major factor that must be considered when evaluating activity levels on a monthly or short-term basis. As many as half of the ship-based personnel might take leave during the first month after returning from the six-month cruise. Despite the fact that such a significant number of persons would be gone at this time, a substantial number of Naval personnel assigned to ships would be taking leave during the remainder of time the battle group was in homeport. Considering leave and out of area training, as many as 1,000 to 1,100 base personnel could be away from the homeport during the months when the battle group was in port.

Figure 2-2 illustrates the month-by-month fluctuations in base personnel likely to take place. Factoring in annual leave, actual homeport staffing could range from about 1,300 when the battle group was on six-month cruise to almost 10,400 when the stand down period was over, ship repair and maintenance crews were at their peak and the destroyer tender was present. A level of about 9,400 persons is expected to occur one month each quarter when the destroy tender would be in port. An estimated 10,100 personnel are anticipated to be present for two 2 to 3 week periods toward the end of the 19 month activity cycle when the air wing personnel would join the battle group.

2.2.3. Repair Activities

Repair activities which would be required to support the Naval Station and the ships homeported there are divided into four categories of maintenance support:

- o Shore facilities maintenance provided by the station's Public Works Department;
- o Ship intermediate level maintenance provided by the Shore Intermediate Maintenance Activity (SIMA);
- o Temporary assignment of a material support ship such as a destroyer tender (AD) to provide backup ship-to-ship support; and
- o Ship depot level maintenance, referred to as Selected Restricted Availability (SRA), provided by a commercial or Navy shipyard at the vessel's homeport.

2.2.4. Hoteling of Ships

When in port, most ships would be in "cold-iron" or "hoteled" at their berths. When hoteled, a berthed ship receives all

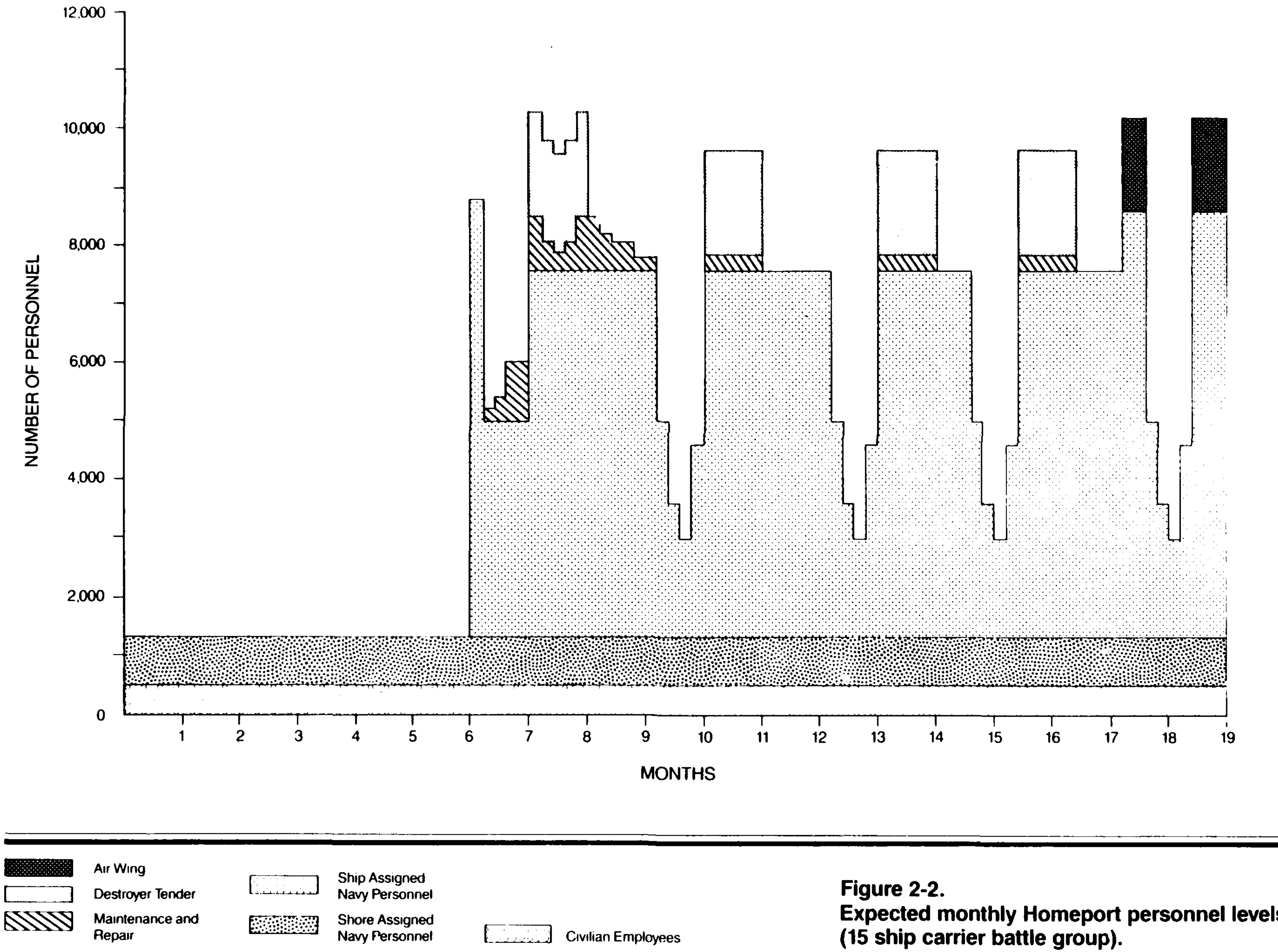


Figure 2-2.
Expected monthly Homeport personnel levels (15 ship carrier battle group).

utilities and collection systems from shore-based facilities. To accommodate the ships, existing or new piers would be fitted with electric, sewer, and water lines. All ships would pump sewage (referred to as "blackwater") to the sewer lines; nine of the ships would pump "graywater"--which consists of non-sewage waste water including galley wastes, water from showers and other types on non-oily water--to the sewer lines. Four ships, two DD and two DDG vessels, do not presently have the capability of collecting graywater for discharge to shore facilities. Operational necessity may dictate the periodic discharge of graywater to Puget Sound from any ship so that there is sufficient capacity to handle all blackwater enroute to open ocean.

2.2.5. Fueling

The Navy proposes the construction of on-site fuel storage at the homeport to support the Carrier Battle Group's fuel requirements. The proposed fuel storage facilities would consist of two 20,000 barrel tanks storing JP-5, a jet turbine fuel, two 30,000 barrel tanks storing DFM (diesel fuel marine), a designated fuel barge loading site, and fuel lines between the fuel tanks and piers.

With fuel storage at Everett, ships would be able to fuel conveniently at their berths and thus avoid the problems associated with barge fueling operations, namely: inclement weather, barge availability, tug availability, increased risk of oil spills, and multiple handling. Overall fuel costs would be reduced and safer operation would result from less handling/ Resupply of the fuel storage tanks by fuel oil barges could be scheduled more conveniently and could take advantage of good weather conditions and competitive transportation costs.

2.2.6. Ordnance

CVBG ships homeported in the Puget Sound area would routinely load/offload ordnance, as required, at the ammunition handling pier at the Naval Undersea Warfare Engineering Station (NAVUSEA-WARENGSTA) Indian Island Ordnance Annex or at sea from Mobile Logistic Support Force (MLSF) ships. Any further construction needed at Indian Island to support this and other regional requirements would be the subject of separate environmental documentation required under NEPA. However, to maintain an acceptable degree of combat readiness, homeport sites for combatant naval vessels are normally designed to allow for the safe conduct of occasional handling of ammunition. Such handling is normally limited to:

- The intra-ship movement of ammunition to allow for maintenance and repair of ships' armament systems;

- The occasional movement of ordnance such as a torpedo from ship to ship;

- Local delivery of limited quantities of ammunition that is in short supply and small arms ammunition pyrotechnic items required for ships' security.

Navy ordnance is in an unarmed or safe condition during handling and storage. This unarmed or safe condition is achieved through design engineering. In an unarmed or safe condition, torpedoes are designed to withstand the external forces that may be applied during handling operations, as well as potential accidental forces such as those that could be encountered if dropped from normal handling heights.

All ship berths at which limited ammunition handling is permitted must comply with Department of Defense (DOD) Ammunitions and Explosives Standards contained in DOD Standard 6055.9 of July 1984. The DOD standard requires specified clear zone distances around each ammunition handling point to ensure the safety of persons and property not associated with the ammunition handling, but that are in the near vicinity. These clear zones are referred to as Explosive Safety Quantity Distance (ESQD) arcs. The sizes of the arcs are directly proportional to the amount and type of ammunition permitted to be handled. An ESQD arc of either 1,250 feet or 500 feet must normally be maintained between an ammunition handling point during the handling of certain torpedoes and other ammunition items and inhabited buildings and public property:

- During ammunition handling operations, which require a 1,250 foot ESQD arc, a minimum distance of 1,250 feet to the closest inhabited buildings as well as a 750 foot distance to a main ship channel must be maintained.

- During the handling of some specific torpedoes, only a minimum ESQD arc of 500 feet must be maintained between the handling point and inhabited buildings and main ship channels.

These distances provide for an acceptable degree of safety to the surrounding area as determined by the DOD Explosives Safety Board. No ESQD arc is normally required during the handling of limited amounts of small arms ammunition and pyrotechnic items. ESQD arcs have been identified in Figure 2-3.

The homeport site would be designed to permit the occasional handling of limited amounts of ammunition and would be in strict compliance with DOD Standard 6055.9. The handling of ammunition at the homeport site would occur within the Naval Station confines, and would normally be limited to a single item, single

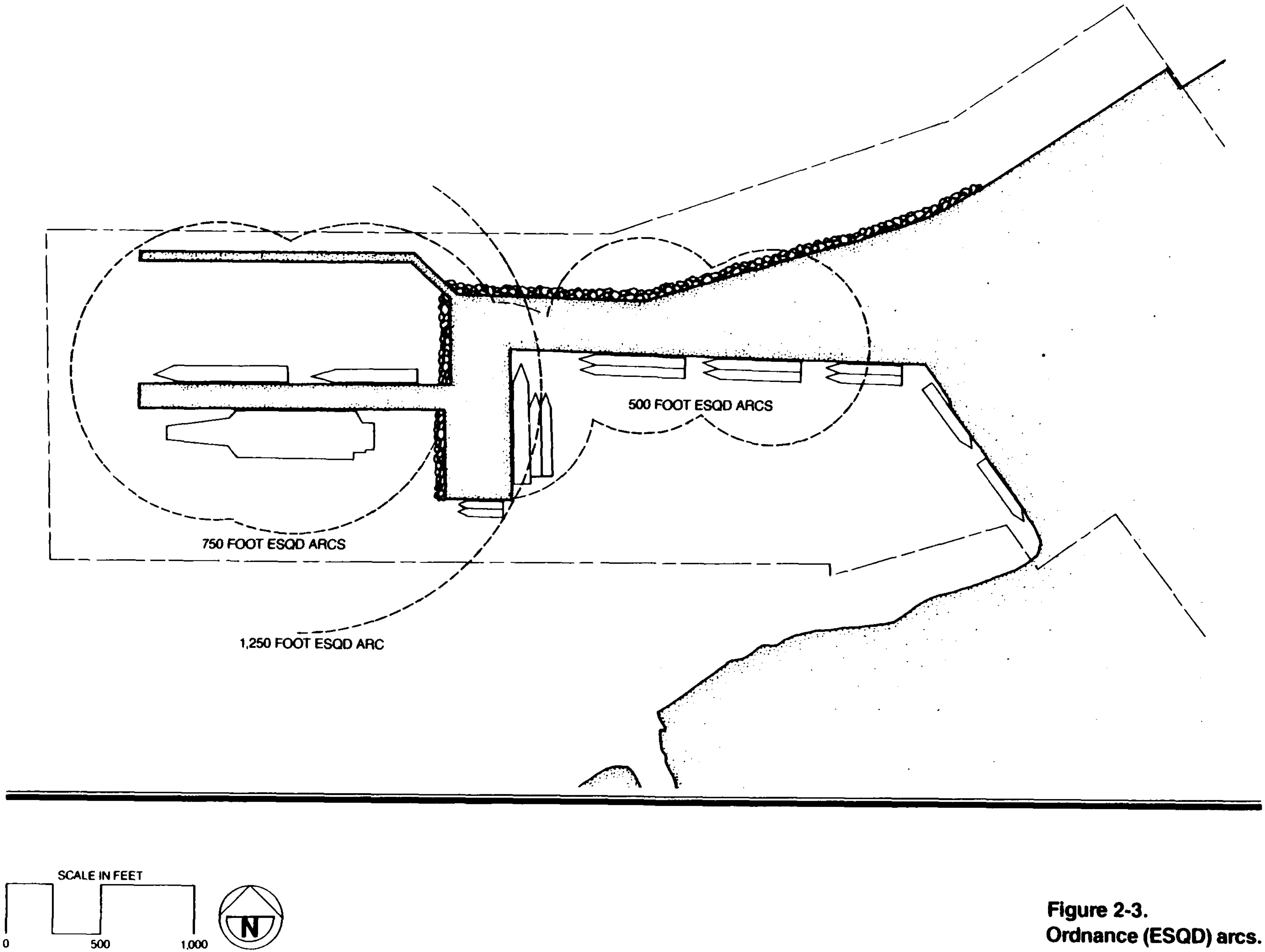


Figure 2-3.
Ordnance (ESQD) arcs.

event operations when torpedoes are involved, i.e., one torpedo at one handling point at the site. Ammunition handling at the points identified on the mole piers would normally be limited to occasional intra-ship or ship-to-ship movement of a single torpedo and the occasional local delivery of small arms ammunition and/or pyrotechnic items required to maintain ships' security. Frequency of ammunition handling at the mole piers would normally not exceed three evolutions per month during the time the ships are in port, two evolutions involving small arms ammunition or pyrotechnic items, and one involving the ship-to-ship transfer of a torpedo. Ammunition handling at the carrier pier would also include the local delivery, by watercraft, of limited quantities of aviation ordnance, torpedoes, or gun ammunition, as well as intra-ship and ship-to-ship movement of limited quantities of ammunition and the local delivery of small arms ammunition and pyrotechnic items. The frequency of ammunition handling evolutions at the carrier pier would normally not exceed two per month--one evolution involving small arms ammunition and one involving aviation ordnance, torpedoes or gun ammunition. The total explosives weight of ammunition anticipated to be handled at any one time on the carrier pier would normally not exceed 10 percent of the amount authorized to be handled by DOD standards when a 1,250 foot ESQD arc is required. Therefore, an additional safety factor of 90 percent would normally be afforded.

The only ammunition that would normally be transported to the site by land would be limited to small arms ammunition and pyrotechnic items. The land transport of ammunition would be in strict compliance with all federal, state, and local transportation and shipping regulations. Normally, the amount of small arms ammunition and pyrotechnic items would not exceed that which can be carried by a single pickup truck and would be less than the amount of ammunition typically supplied to sporting goods stores. Routes to the homeport site would be established as directed by the Washington State Department of Transportation and the City of Everett. The frequency of small arms ammunition and pyrotechnic items shipments is not expected to exceed two per month during the time the ships would be in port.

The transport of limited amounts of ammunition, torpedoes, and gun ammunition by watercraft from NAVUSEAWARENGSTA Indian Island Ordnance Annex to the homeport site would occasionally be required. This ammunition would be handled at the carrier pier and would normally not exceed 10 percent of the amount authorized for handling on the pier. The frequency of this type of transport and handling is not expected to exceed one evolution per month during the time the carrier would be in port.

2.2.7. Construction

Construction at the homeport site would involve demolition of virtually all existing buildings on-site (except the chill facility) and construction of new buildings, utilities, parking areas, and recreational facilities. The large "L" shaped pier (also called a "mole") at the south end of the existing facility would be reconstructed and three smaller existing piers would be removed. Approximately 10 acres of existing fill associated with the L-shaped mole pier would also be removed. Table 2-3 lists the capital improvements scheduled for construction. Design of all facilities will be subject to several professional reviews by civilian engineers under contract to the Navy as well as Navy engineering personnel and will be required to meet design standards established by the Navy.

Two aspects of construction, the marine oriented facilities such as wharves and piers and those related to dredging and dredge disposal, are particularly important from an environmental perspective and are described in greater detail below.

2.2.7.1. Wharves and Piers

During the initial period of homeport construction an armor rock breakwater approximately 1,600 feet long would be constructed on the west side of the carrier pier to protect the ships from waves. The breakwater would be constructed by dredging to the required foundation depth and barging in and dumping quarry spall core, a rock layer, and an armor rock wearing surface.

Also in fiscal year 1987, approximately 2,400 linear feet of seawall on the west side of the existing mole would be strengthened by additional armor rock. Approximately 3,250 linear feet of shoreline on the north and west inner harbor boundaries would be cleared, reshaped, and protected by new riprap construction.

The surface of the existing mole would be raised to a finished subgrade elevation of 18 feet to allow connection to the carrier pier and the south marginal wharf. Riprap slope protection would be provided on the south mole slopes to protect the mole from erosion forces caused by waves, tides, and ship propellers.

During fiscal year 1987, the carrier berthing pier would also be constructed. This pier would be a concrete structure approximately 1,600 feet long and 126 feet wide complete with all utilities. The deck elevation would vary from 19 feet at the south mole to a high point at the south end of the pier. The principal features of the carrier pier include a prestressed concrete piling foundation, cast-in-place pile caps, prestressed precast deck panels, pavement topping, a fender system, and utilities for ship support. The utilities consist of a utilidor (concrete utilities trench), a sanitary sewer system, a potable

Table 2-3. Construction projects by fiscal year.

Project No.	Title	Scope
Fiscal Year 1987		
P-111	Carrier Group Facilities	Breakwater (LF)
		Outer Harbor Dredging (CY)
		Mole (TN)
		Shoreline Dredging (CY)
		Shoreside Fill (CY)
		Slope Protection (LF)
		Demolition (CF)
		Telecommunication (MI)
		Electric Power (kW)
		Steam Plant (million Btu)
		Compressed Air Plant (EA)
		Roads (LF)
		Parking (spaces)
		Carrier Pier (SY)
Fiscal Year 1988		
P-045	Shore Intermediate Maintenance Activity (SIMA)	
P-107	Morale, Welfare, and Recreation (MWR), Increment 1	
P-112	Dredging, Inner Harbor	
P-116	Utilities, Second Increment	Potable Water Lines (LF)
		Gas Lines (LF)
		Utilidor (LF)
		Steam Plant (million Btu)
		Compressed Air Plant (EA)
		EMCS (EA)
P-117	Security Facilities	
P-121	South Marginal Wharf	
P-127	Port Services and Public Works	

Table 2-3. Construction projects by fiscal year (cont.).

Project No.	Title	Scope
P-145	Naval Telecommunications Center	
P-147	Location Exchange	
P-902	Land Acquisition	
P-905	Outer Harbor Dredging	
Anticipated Construction Beyond 1988		
P-104	Industrial Complex, Logistics	
P-110	Ground Support Equipment (GSE) Shop and Shed	
P-118	Sports Complex	
P-125	Fleet Support Facilities	
P-126	Transit Shed and Covered Storage	
P-128	Circulation and Site Improvements	Roads and Parking Fencing Utilities Landscaping
P-144	Radar Collimation Tower	
P-990	EEQ and Galley	
P-[illegible]03	Administration Facility, Everett	
[illegible]-105	Direct Fueling	
P-108	Medical/Dental Clinic	Seattle Everett
P-109	Training Complex	
P-123	Central Marginal Wharf	
P-139	Bowling, Alley, Increment I	

Table 2-3. Construction projects by fiscal year (cont.).

Project No.	Title	Scope
P-129	Public Works, Sand Point	
P-131	Administration, Sand Point	
P-133	MWR, Increment II	
P-141	Exchange/Commissary, Sand Point	
P-132	Firing Range, Sand Point	
P-135	Disciplinary Barracks, Sand Point	
P-136	Brig Addition, Sand Point	
P-137	MWR, Increment III	
P-140	Bowling Alley, Increment II	

water system, a saltwater system including a saltwater pump station adjacent to the pier, compressed air, steam, condensate return, telecommunications, electrical service, lighting, and cathodic protection.

In fiscal year 1988, work would begin on the south marginal wharf. The wharf, to be constructed around the mole which would be prepared earlier, would be adjacent to the carrier pier and connected to the central marginal wharf to the north. The north face of the south marginal wharf would measure about 906 feet with the eastern 750 feet being available for ship berthing, and the western 165 feet would be covered by the central marginal wharf. The east face would measure about 325 feet and would be used for berthing. The south face would measure about 319 feet and would probably be used for small craft berthing. Final deck elevation would be approximately 19 feet. The permanent concrete wharf would be concrete pile supported and would include a fender system. Complete utilities for cold iron berthing would be provided, including potable water, saltwater, compressed air, steam, condensate, telecommunications, electrical service, sanitary sewer, lighting, and fuel supply.

In later fiscal years 1990 the central marginal wharf would be constructed. The central marginal wharf would be approximately 2,170 feet long and 165 feet wide. Construction and utilities would be similar to the south marginal wharf.

2.2.7.2. Dredged Material Disposal

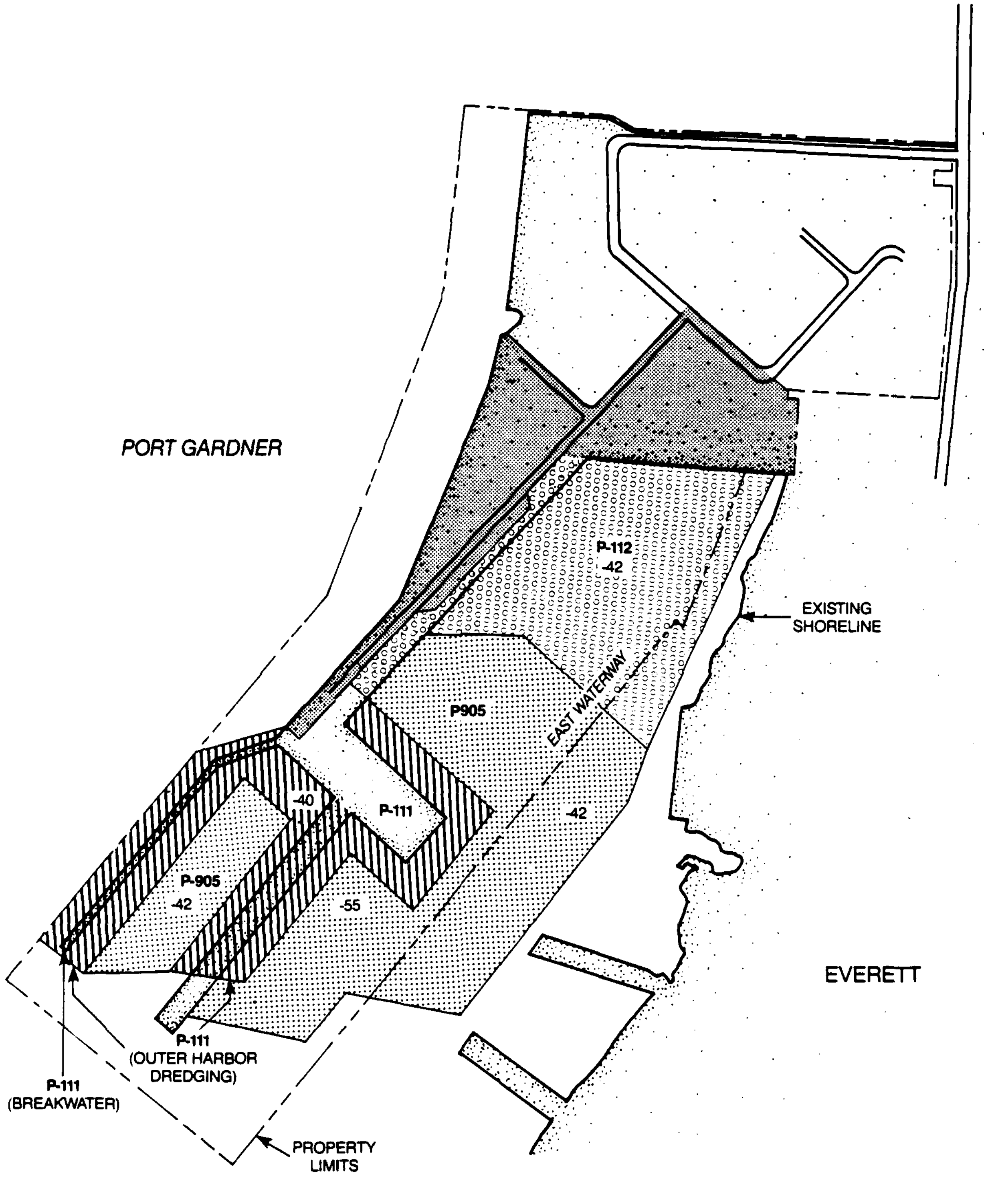
Three dredging projects have been identified as part of the homeport construction:

- P-111 Outer harbor dredging, breakwater, and mole
- P-905 Outer harbor dredging, second increment
- P-112 Inner harbor dredging

The P-111 dredging project would be conducted in fiscal year 1987 and the P-905 and P-112 projects would take place in fiscal year 1988. Figure 2-4 shows the location of each dredging project.

The initial portion of dredging, P-111, would be done to accommodate the construction of the carrier pier, breakwater, and south mole. Dredging would be done to elevation -42 feet MLLW in the carrier pier area and the area adjacent to the south mole. Dredging for the breakwater would vary from -30 to -60 feet MLLW after dredging.

Under project P-905, dredging in the outer harbor area would be conducted to provide the required final elevations for berthing and turning channels for the carrier and major combatants. Dredging for the carrier berth would be to an elevation of -55 feet from the east face of the pier to a location 470 feet to the



FY87 Projects

P-111 Outer Harbor Dredging, Breakwater, and Mole

FY88 Projects

P-112 Dredging Inner Harbor

P-905 Dredging Outer Harbor

Figure 2-4. Project Dredging plan.

east. The turning basin would be located east of the carrier berth and would be dredged to an elevation of -50 feet. The area between the carrier pier and the breakwater would be dredged to an elevation of -42 feet as would the areas north and east of the mole. As part of project P-112, the inner harbor area would be dredged to an elevation of -42 feet to allow turning and berthing. In the northeastern sector of the P-112 dredge area, depths already exceed -42 feet elevation but would be dredged to remove 54,500 cubic yards of contaminated materials below project depth to allow a thorough cleanup of the project areas. The resulting depression will then be filled to -42 feet elevation to eliminate hydraulic stagnation and related potential future trapping of fine sediments.

A number of studies have been conducted to identify the biological and chemical characteristics of the materials to be dredged. These studies are discussed in detail in Chapter 4, Section 4.1. In summary, the upper portion of the East Waterway sediments has been classified as contaminated and the underlying sediments meet criteria to be classified as clean.

The volume of sediments classified as contaminated has been defined in terms of the dredging procedures used to remove it. The "in situ contaminated" volumes shown in Table 2-4 refer to the minimum quantity of sediments that includes all of the contaminated material plus an additional one foot minimum depth. The "dredge contaminated" volumes represent a dredging plan that is more practicable to achieve in the field. This will ensure that all contaminated sediments are removed. The "dredge clean" amounts are the volumes of clean sediments remaining after dredging the "dredge contaminated" volume including a one foot overdepth allowance.

Table 2-4. Estimated Everett homeport dredge quantities (cubic yards).

Project Number	In situ Contaminated	Dredge Contaminated	Dredge Clean	Dredge TOTAL
P-111	65,800	97,000	739,000	836,000
P-905	197,300	224,500	1,140,000	1,364,500
P-112	223,800	552,000	498,000	1,050,000
		54,500*		54,500*
	486,900	928,000	2,377,000	3,305,000

* Contaminated sediment below project depth in P-112.

Five disposal methods and ten disposal sites were evaluated in terms of environmental impacts, engineering feasibility, and cost. Detailed analysis of the behavior of the dredge material during deposition, entrainment of contaminants in the water column, surface and subsurface currents, and site specific characteristics were conducted for each alternative disposal site. As a result of review of the sites and further analysis after distribution of the DEISS, confined aquatic disposal (CAD) at the Revised Application Deep (RAD) CAD site was selected as the most effective means of disposing of both the contaminated and clean dredge materials. RAD CAD, which is located in deeper water than other CAD sites, was evaluated in order to minimize impacts to Dungeness crabs.

A variety of dredging methods were evaluated for both the contaminated and clean sediments in concert with the assessment of alternative dredge disposal sites and procedures for depositing the dredge material in an environmentally sound manner. Studies of CAD in Port Gardner (Appendix B of the DEISS) determined that the most suitable method of dredging the contaminated would be to use a clamshell dredge so that it would have minimum contact with the water column. The contaminated material would then be transported to the disposal site by barge. The clean material would then be dredged using either a hydraulic or clamshell dredge and transported to the disposal site by either a pipeline or pumpout barge.

The center of the Revised Application Deep Confined Aquatic Disposal Site (RAD CAD) is located approximately 9,000 feet from the proposed homeport site and is offshore from the mouth of the Snohomish River. The disposal site design is approximately 3,800 feet by 6,000 feet (380 acres) in size. The RAD CAD site is situated in depths ranging from -310 feet to -430 feet MLLLW. The seafloor at the proposed RAD CAD site slopes downward to the southwest at rates varying between 35 feet horizontally to 1 foot vertically and 60 feet horizontally, until it reaches an elevation of approximately -430 feet MLLW.

The design criteria used for the RAD CAD design is conservative to assure identification of total site impact and the capability to accomplish the precision placement and capping of the sediments. Design criteria included use of sediment void ratios for deposition volume and long-term consolidation, disposal site slopes for stability, sediment spread resulting from surface and subsurface release, and application of these design parameters to the actual bed contours.

Control of the point of discharge of sediments also impacts the design. This control is being provided in the plans and specifications for completion of the dredging and disposal.
Position control for contractor placement will be by electronic positioning with both computer printout of x-y position and

concurrent x-y plot. The contractor will not dump sediments without confirmation of correct position. Monitoring of the actual sediment fate by electronic survey and surface borings will allow modification of contractor operation to assure disposal is accomplished as proposed.

Dredging operations would commence after the end of the fish window period (June 15). A berm would be constructed over a period of six weeks using material clamshelled from the breakwater and carrier pier areas. Dredging of contaminated material during FY 1987 (97,000 cubic yards) by clamshell would take approximately three weeks. The dredge contaminated material would be deposited at the RAD CAD site by bottom dump barge, with approximately three barge loads being made every two days. This material would then be covered with clean material dredged hydraulically or clamshelled, carried to the disposal site by pipeline or pumpout barge, and allowed to settle on top of the dredge contaminated material as a cap. The latter operation, which would begin immediately after the contaminated material was in place, would take approximately five weeks.

Dredging operations for FY 1988 (P-905 and P-112) would also begin after the end of the June 15 fish window. A total of 831,000 cubic yards of dredge contaminated material would be removed from East Waterway by clamshell dredge and deposited by open bottom dump barge at the disposal site. It should be noted that the amount of dredge contaminated material to be removed from the East Waterway includes 54,500 cubic yards of material that is at depths greater than required for the Navy's proposed project so that all contaminated material can be removed from the project area. An estimated five barge loads would be deposited every two days. The barges would be positioned so that the previous year's disposal area would be covered with the new material. Disposal of the dredge contaminated material could take up to three months. Immediately after this operation was completed, the remaining clean material (1,638,000 cubic yards) would be dredged hydraulically or by clamshell dredge, and used to cover the disposal area with a cap that would be a minimum of one meter (3.3 feet) thick after settlement and compaction occurs. The latter dredging operation for clean materials would take approximately three months.

The sequencing of the disposal efforts, (i.e. berm construction with clean sediments, placement of contaminated sediments and capping of the contaminated, allows evaluation of a clean sediment deposition prior to deposition of any contaminants. The placement of a smaller amount of contaminants the first year relative to capping sediments provides a best assurance that the capping effort will be successful. Evaluation of this effort will then allow revision of the second year's dredging as necessary.

Criteria for judging success will be developed with the regulatory agencies prior to initiating dredging and disposal. Evaluation approaches will include field monitoring to determine areal extent and thickness of the berm, the contaminated deposit and the cap materials in relation to disposal placement methods. As a minimum, this monitoring will include precise bathymetric surveys, electronic positioning of disposal monitoring equipment, and core samples in and surrounding the disposal area. Supplemental monitoring to be considered include water quality, side scan surveys, and REMOTS. The final monitoring program will be identified to satisfy the agency criteria for CAD success.

Monitoring will be conducted during construction with a view toward guiding or revising construction methods to assure CAD success. Monitoring during and immediately after each phase will allow time for implementing any needed remedial action, including disposal technique revision, delay of placement, and/or additional cap materials. The only identifiable reason for cap failure is insufficient volume of cap materials. For this condition, import of additional materials is an appropriate remedial measure.

2.2.8. Access Road

Several homeport access road alternatives connecting Marine View Drive to east-west routes are presently being discussed by the Navy and the City of Everett. These alternatives include:

- An elevated roadway with two northbound lanes and a sidewalk; three surface level southbound lanes and one northbound lane. Under this alternative 21st Street would be closed.

- A seven lane surface route on Marine View Drive from 19th Street to Everett Avenue that would narrow to five lanes from Everett Avenue to connect with Pacific Avenue. Under this alternative 22nd, 23rd, 24th, 25th, and 26th Streets would be closed.

- A five lane surface route connecting Marine View Drive with Pacific Avenue.

2.2.9. Naval Station Seattle (Sand Point)

The proposed project site in Everett is not large enough to accommodate all of the support services necessary to sustain the carrier battle group personnel and their dependents. The most economical approach to provide these services is to expand upon the existing organizational structure and facilities already located at Naval Station Seattle (Sand Point). Depending on where Navy families locate within the King/Snohomish County area, these facilities should be accessible and reasonably convenient

for service personnel and their dependents. Clearly, alternative arrangements must be made for certain services such as emergency medical treatment which would be accommodated by use of a small medical/dental clinic at the proposed homeport site and private health care by contract and/or CHAMPUS programs. The need for adjusting locations and types of services provided will be re-evaluated as Navy personnel and their dependents locate in the area.

Due to space constraints at the Everett site, all or some of the following facilities would be located at Naval Station Seattle:

- Armory (rehab)
- Indoor Range (rehab)
- Auto Maintenance Shop (rehab)
- Paving and Grounds Shed (rehab)
- Medical/Dental Clinic (rehab)
- Administrative Space, Public Works, Data Processing, Personnel (rehabilitation)
- Data Processing (rehabilitation)
- Dog Kennels
- Childcare Center
- Library/Educational Services Center (rehabilitation)
- Hobby Shops
- Class VI Store (expansion)

These facilities are described in greater detail in the Navy FEIS.

3. DREDGING/DREDGE DISPOSAL ANALYSIS

For a comprehensive discussion of the various testing methods and test results which support the conclusions summarized in this chapter, please refer to Appendix D of Volume 2 of the DEISS. References to Appendix D of DEISS throughout this chapter are intended to direct the reader to that source.

Three dredging projects have been identified as necessary for construction of the homeport:

- P-111 Initial dredging of the outer harbor to accommodate construction of the carrier pier, breakwater, and south mole.
- P-905 Second increment of outer harbor dredging to provide the required final elevations necessary for maneuvering of Navy vessels.
- P-112 Inner harbor dredging to provide required final elevations and removal of contaminated sediments.

Studies conducted to identify biological and chemical characteristics of materials to be dredged, indicated that the upper portion of East Waterway sediments are contaminated. In order to handle these and the uncontaminated sediments in the best possible manner, a variety of dredging methods have been evaluated in concert with an assessment of nine disposal sites, and five different procedures for depositing the dredged material in an environmentally sound manner.

The purpose of this section is to provide additional information concerning the dredging and dredge disposal program alternatives associated with the proposed project. Key aspects of the analysis include: an overview of project-specific data collection and analysis conducted since the Navy FEIS distribution; an explanation of the need for project-related dredging; quantities and characteristics of the dredge material; potential dredging methods; and the dredging and disposal strategies that could be applied in conjunction with alternative dredge disposal sites. The preferred dredging and dredge disposal alternative is based on the fact that 97,000 cubic yards of contaminated sediment and 739,000 cubic yards of clean sediment are to be dredged from East Waterway in fiscal year 1987 and that 831,000 cubic yards of contaminated sediment and 1,638,000 cubic yards of clean sediment are to be dredged in fiscal year 1988. Contaminated surface sediment would be removed using a clamshell dredge and the clean sediment below would be removed via either a hydraulic or clamshell dredge and deposited using a pipeline with diffuser or pumpout barge, respectively.

The preferred disposal site, referred to as the Revised Application Deep Confined Aquatic Disposal (RAD CAD) site is located approximately 2.1 nautical miles west of the proposed homeport. The RAD CAD site is 380 acres in size and ranges in depth from approximately 310 MLLW to 430 MLLW.

The disposal strategy is to deposit the contaminated sediment by open bottom dumping from a barge and subsequently capping the contaminated sediment with clean sediment that is put in place hydraulically by pipeline dredge or pumpout barge. Prior to dredging the contaminated sediments, a berm will be placed downslope to contain the migration of initially deposited clean sediments and to verify the validity of design criteria assumptions. Dredging and disposal operations would be conducted for approximately three months in fiscal year 1987 and six months during FY 88. Operations would be scheduled to provide a "fish window" when no dredging or disposal would take place.

3.1 Dredging Analysis Conducted Since FEIS

Since completion of the Navy FEIS in June 1985, a wide array of technical data collection and analysis has been conducted to evaluate of dredging and disposal alternatives and final design. These studies include characterization of the dredging materials, engineering aspects of dredging and disposal, and site-specific disposal analysis. Major contributions were made by the U.S. Army Corps of Engineers, Seattle District, and Waterways Experiment Station (U.S. Army Corps of Engineers, NPS, and WES) and the Navy design team. Brief summaries of significant new work are outlined below.

3.1.1 Dredged Materials

3.1.1.1 East Waterway Sediment Distribution

As reported in the Navy FEIS, the U.S. Army Corps of Engineers, Seattle District (NPS), collected core samples from 19 and 20 stations in the East Waterway dredging area in July 1984 and February 1985, respectively, (U.S. Army Corps of Engineers, NPS, 1984, 1985). Based on these results and in consultation with state and federal resource agencies, Seattle District defined the general character and distribution of contaminated sediments overlying the cleaner materials (U.S. Army, 1985a). Subsequently, U.S. Army Corps of Engineers Seattle District collected and composited 8 cubic yards of contaminated sediment from 14 representative sites in East Waterway. This composite sample was furnished to the Waterways Experiment Station (WES) for complete analysis and testing to describe its physical and chemical properties and resulting dredging/disposal characteristics (U.S. Army, WES, 1986a). In August 1985, Hart-Crowser and Associates, Inc., collected an additional 25 core samples supplemented by side-scan

sonar and divers to describe sediments and debris in the dredging area (Hart-Crowser, 1985).
Based on review of all data, Seattle District defined physical parameters (color, odor, chips) for identification of contaminated sediments. These parameters were then applied by the Navy to assess the extent of contaminated sediments to be dredged (Otten, 1985; U.S. Army 1986b).

3.1.1.2 Dredging Volumes

Using the sediment definitions provided by Seattle District (above), and results of core-sampling by Hart-Crowser in August 1985, volumes of sediment to be dredged from East Waterway were calculated in terms of 1) clean sediment, 2) contaminated sediment, and 3) debris (ABAM, 1986). Dredge quantities are shown in Table 3-1 of this document.

Table 3-1. U.S. Navy Homeport Dredge Quantities (cubic yards).

Project Number	In situ (1) Contaminated	Dredge Contaminated	Dredge Clean	Dredge TOTAL
P-111	65,800	97,000	739,000	836,000
P-905	197,300	224,500	1,140,000	1,364,500
P-112	223,800	552,000	498,000	1,050,000
		54,500 (2)		54,500
	486,900	928,000	2,377,000	3,305,000

(1) Overdepth Included in Dredge Contaminated.
(2) Contaminated Sediment Below Project Depth in P-112.

3.1.2 Sediment Characterization

A comprehensive sediment characterization study has been conducted on East Waterway contaminated sediments by WES using the 14-site composited sediment sample collected in June 1985. Tests and results are reported in Appendix D of the DEISS and summarized below:

3.1.2.1 Sample Collection/Preparation

Samples of the contaminated sediment layer were collected by clamshell dredge from 14 representative sites in East Waterway. The samples were homogenized into a single large sample, placed in containers and shipped to WES at Vicksburg, Mississippi for testing. This homogenized composited sample was used by WES for all analysis and testing to guide dredging and disposal modeling and impacts evaluation.

A representative compositing scheme was selected based on obtaining a sample which was as representative as possible of the entire volume of contaminated sediments to be dredged. Performing the entire suite of environmental tests on multiple samples from this project, or any project, was determined to be economically and logistically impractical. The objective of the compositing scheme was to obtain as representative sample as possible of the entire volume of contaminated sediments to be dredged. This approach was reviewed and approved by key State and Federal agencies prior to sample acquisition.

A reference water sample was collected from near-bottom waters offshore of the Port dock immediately outside the East Waterway in September 1985. Water collected at this location was considered chemically representative for both the dredging site and the CAD disposal site. This water was used in selected sediment tests to provide site-specific results for interpreting dredging/disposal impacts.

3.1.2.2. Sediment - Physical and Chemical Characterization

A physical and engineering characterization of the homogenized composite sample was conducted by WES Geophysical Laboratory. This included water content, specific gravity, grain size distribution, Unified Soil Classification, and Atterberg limits (related to plasticity).

The composite sample was chemically analyzed for bulk concentration of priority pollutants. Most components were at or below detection limits. Based on the results, a list of 32 representative parameters of specific compounds of concern was developed in consultation with Seattle District, including heavy metals, polychlorinated biphenyls, and polyaromatic hydrocarbons. This list of chemical parameters of concern was used as the basis for further testing of chemical solubility/mobility and related evaluation of impacts.

Methods and results for all sediment tests are presented in Appendix D of the DEISS.

3.1.2.3. Water Chemistry

The harbor reference water sample was also analyzed by WES to provide a reference for evaluating detailed tests. This reference water was not the basis of final evaluation. Results of elutriate and surface runoff tests were compared with Federal water quality criteria for the protection of salt water aquatic life. For the leachate tests, results were compared with EPA and State of Washington drinking water standards. These comparisons are presented in the technical appendix (Appendix D of the DEISS).

3.1.2.4. Elutriate Tests

WES conducted elutriate tests on contaminated sediments to estimate the amount of dissolved and/or suspended contaminant released upon dredging and disposal. Tests were run by mixing appropriate ratios of the composited sediment and the reference water samples and allowing the mixture to settle. Standard elutriate test results are used to estimate the degree of dissolved contaminant release due to placement of the sediments at open water sites.

Modified elutriate tests measure contaminant release by both the dissolved and particle-associated fractions. The test accounts for the settling behavior of the dredged materials and physical and chemical characteristics of the disposal area. The modified elutriate test results are used as a basis to predict the quality of water discharged as effluent from a confined nearshore or upland disposal area.

Elutriate test methods and results are presented in Appendix D of the DEISS.

3.1.2.5. Settleability

WES conducted settling tests on East Waterway sediments to define sedimentation processes and settling rates. Sediment-water slurries representative of hydraulic dredging were settled under laboratory conditions. Rate of sedimentation and remaining suspended solids concentrations in the supernatant were monitored with time. Results were used to derive nearshore or upland confined disposal site geometry for effective sedimentation and effluent control (Appendix D of the DEISS).

3.1.2.6. Surface Runoff

Characteristics of surface runoff (rainfall events) from exposed contaminated soils from East Waterway were determined by WES using a Rainfall Simulator-Lysimeter. Tests were conducted for both the wet condition representative of initially placed materials, and for the mature condition following several months of natural atmospheric drying and oxidation. Water samples from the bulk surface runoff were collected and analyzed for contaminants including suspended solids. Additional filtered samples of bulk surface runoff, representing the dissolved fraction remaining after removal of suspended sediments, were also analyzed. Test results provided the basis for design controls for a nearshore or upland disposal site for exposed contaminated East Waterway sediments. Test methods and results are contained in Appendix D of the DEISS.

3.1.2.7. Leachate Prediction

Laboratory tests have been conducted by WES to relate expected generation of leachate to contamination levels of East Waterway

sediments. These results provide a basis to evaluate the potential for leachate generation and groundwater impacts for confined dredge material disposal to nearshore or upland sites. In the tests, clean water is passed through contaminated sediments and resulting leachate concentrations are measured. Relationships established between sediment contamination and leachate concentrations can be used with chemical and mass transfer equations to mathematically evaluate potential groundwater impacts for a given dredge disposal site.

Two types of tests are being conducted: 1) batch tests to describe the observed relationships between sediment contamination and leachate concentrations, and 2) continuous flow permeameter testing to provide a basis for confirming predictability of leachate generation. Both anaerobic and aerobic phases of East Waterway sediments were tested.

To the extent that leachate predictability is confirmed by laboratory testing, field impacts can be estimated for specific disposal site conditions. Test methods, analytical approach and results to date are contained in Appendix D of the DEISS.

3.1.2.8. Capping Effectiveness

Tests were conducted by WES to determine the minimum cap thickness required to chemically isolate a deposit of contaminated East Waterway sediment from overlying water column. This test approximated the design condition for deep Confined Aquatic Disposal of contaminated sediments. Laboratory tests conducted in a plexiglass cylinder utilized the relatively clean native sediments as the capping material. Tracer contaminants migrating through the cap to the water column were measured for increasing cap thickness until a negligible contaminant transfer was achieved. Final design of cap thickness was determined by adding a depth of capping sediment to protect the chemical cap integrity from bioturbation effects based on other capping effectiveness tests. Methods and results are contained in Appendix D of the DEISS.

3.1.2.9. Sediment Stabilization Potential

WES conducted tests to determine effectiveness of selected additives in improving compressive strength and leachability of East Waterway contaminated sediments. Setting agents tested include lime, fly ash, portland cement and Firmix (proprietary). Various combinations and concentrations were mixed with East Waterway sediments and the resulting impacts on compressive strength and leachate concentrations were measured with time for 28 days or more. Results may be used to estimate the practicability of using solidification/ stabilization techniques as a means of limiting permeability of East Waterway sediments (i.e., a quasi-liner) and reducing leachate and its resulting impact on groundwater quality. Methods and results are reported in Appendix D of the DEISS.

3.1.3. Open Water Disposal Modeling

Numerical modeling was conducted by the WES Hydraulics Laboratory to determine behavior of the contaminated dredged material during placement for a Deep Delta Confined Aquatic Disposal (CAD) alternative. Modeling was also accomplished to evaluate the ability to control placement of a cap of uncontaminated sediments over the contaminated dredge material. Modeling was first conducted for disposal of one barge load of contaminated material released at the surface and for one barge load dropped incrementally through a vertical downpipe to the bottom (Appendix D of the DEISS). Subsequent design revisions required modeling of the cap placement from pipeline discharge at the surface and at various subsurface depths (Appendix B of the DEISS).

The model used was specifically designed to analyze instantaneous surface discharge of sediments from a barge or scow. Specific East Waterway sediment characteristics were used in the model, and site-adapted coefficients were used to describe the dynamic depositional processes. Modeling was run for two different current velocities and a range of "clumping" factors.

Modeling results have been used to evaluate alternatives and impacts for CAD, and to design placement and configuration of the final contaminated sediment disposal and cap.

3.1.4 Dredging/Disposal Equipment Evaluation

WES conducted a preliminary dredging equipment evaluation (Appendix D of the DEISS). This work updates similar data in the Navy FEIS to provide specific alternatives for deep-water confined aquatic disposal and confined nearshore/upland disposal. Equipment performance goals and options are identified, and construction recommendations made. Means to reduce loss of contaminated sediments due to resuspension during dredging are provided. Project design and equipment selection reflects use of this data.

3.1.5 Design Requirements (Criteria)

Based on results of sediment characterization, disposal modeling, and equipment evaluation (above) WES has prepared design criteria for dredged material disposal alternatives under consideration. This includes both confined aquatic disposal (CAD) and confined nearshore/upland disposal.

For CAD, evaluated design requirements included placement of materials in deep water, the potential use of subaqueous confinement (berms), submerged discharge and the minimum cap thickness. For confined nearshore/upland disposal identified design requirements are: volumetric, surface area, effluent suspended solids, and weir design for the settling pond area;

effluent, surface runoff, and leachate controls; and surface cap. Monitoring requirements are outlined. Feasibility of alternatives based on mass release (contaminant losses) is presented for both CAD and nearshore/upland confined disposal in terms of meeting a performance objective to minimize mass release to less than about 5 percent.

These design requirements are key results of the extensive testing, modeling, and evaluation provided by WES as technical assistance to the U.S. Navy Homeport design project. These design requirements provide specific basis for evaluation of dredging and disposal alternatives and for related final design.

3.1.6. Alternative Dredge and Disposal Methods

Feasibility of disposal alternatives was studied by ABAM Engineers, Inc. (ABAM, 1986). Based on identification of alternatives by the U.S. Navy, ABAM prepared feasibility-level evaluations for dredged material disposal at the following sites: CAD at the Deep Delta Site; unconfined disposal at the Port Gardner deep water site (this site is presently closed); nearshore site at inner end of East Waterway; nearshore site on Snohomish River upstream from the proposed Navy Homeport project. Subsequent to the ABAM study, the use of Smith Island as an upland site was evaluated as was a CAD site southwest of the Deep Delta CAD site (designated Southwest Deep CAD), and a revised application Deep CAD site (designated RAD CAD).

The studies examined each of the proposed sites, identifying site characteristics, ownership, geotechnical considerations, impacts of settlement on adjacent existing and future structures, containment structures, quality of effluent waters, dredging and disposal techniques, constraints to use, disposal capacity, impact on construction schedule, and cost.

Results of the alternatives feasibility studies have been used in preparation of this EIS Supplement and for final disposal site selection by the U.S. Navy (Appendix C of the DEISS).

3.1.7. Harbor Circulation/Sedimentation

NORTEC has completed hydraulic and numerical modeling studies to evaluate water circulation and sedimentation patterns in Everett Harbor. Final results and report are scheduled for November 1986. Study phases include collection of field data to provide a basis for model calibration; building and testing of a hydraulic model to describe Harbor water circulation patterns in relation to Snohomish River and Port Gardner; and numerical modeling of Harbor siltation rates based on prototype (field) data and hydraulic model results. Study results will be used to project future sedimentation patterns and related need for maintenance dredging.

This modeling will not be the sole basis for determining future maintenance dredging requirements. It will be used to supplement previous information on harbor maintenance dredging (U.S. Navy FEIS, 1985, Appendix A) and future hydrographic condition surveys. Preliminary data indicates that future maintenance dredging may be required at five to ten year intervals. Future maintenance dredging would be subject to separate permitting requirements at the time of proposal.

3.1.8. Deep Delta Confined Aquatic Disposal

3.1.8.1. Bathymetry

A complete reconnaissance bathymetric and marine geophysical survey was conducted of Port Gardner during July 1985, by Northern Technical Services. The area surveyed includes all the proposed Deep Delta Confined Aquatic Disposal Sites. Methods included use of seismic bottom profiling for determining geophysical stratigraphy; precision depth sounding for describing bathymetry; and side scan sonar to identify seafloor features and provide continuity between bathymetric lines.

3.1.8.2. Currents

A comprehensive current monitoring study of the Deep Delta disposal site was conducted in January and February 1986 by Northern Technical Services. The program included deployment of three moored current meter arrays for 31 days near the disposal site and the analysis of current data from nine recording current meters. Objectives of the program were to characterize current velocities throughout the water column and across the disposal site during varying conditions of tide, meteorology and Snohomish River runoff.

Currents were measured near the surface, at 70 feet and 170 feet depths, and near-bottom near the center of the site for the full study period. A "roving" current meter array was moved at weekly intervals to selected locations around the perimeter of the disposal site. A major storm event with high winds, rainfall and surface runoff occurred in January and is captured in the database.

Study results were used as site-specific input to model simulations of dredged material disposal, site and equipment design, and in evaluation of potential impacts. Current study methods and results are presented in Northern Technical Services (1986b).

3.1.8.3. Geotechnical

Feasibility level geotechnical engineering studies were conducted for the Deep Delta CAD site by Hart-Crowser & Associates, Inc. Evaluations were based on Northern Technical Services's seismic and bathymetric surveys of Port Gardner (Northern Technical Services, 1986a) and fifty-five bottom core and grab samples collected from

the CAD area. Soil stratigraphy was described and sediments were analyzed for geophysical characteristics. Evaluations were conducted to describe the site soil strength in terms of stability to receive dredged materials. Berm stability, slope factors, and construction approach were evaluated. Long term settlement of the dredged material and berm was estimated as a function of consolidation within the dredged deposit and subsoil. Benthic organisms collected in the bottom samples were also noted. Methods and results are reported in Hart-Crowser (1986).

Northern Technical Services conducted radioactive dating studies of sediment core-samples collected from the Deep Delta CAD site. The age of sediment layers and related average accumulation rates were estimated based on concentration of solids and stable lead and copper, and radiometric analyses of the cores using a Lead (210_{Pb}) technique. Results show that all of the CAD sites are in a long-term accretion zone. Methods and results are presented in Appendix D of the DEISS.

3.1.8.4. Confined Aquatic Disposal Design

Based on disposal site selection by the Navy, ABAM Engineers, Inc., prepared a 35 percent Basis of Design document including dredging of East Waterway (ABAM, 1985). The disposal site selected by the Navy was confined aquatic disposal (CAD) at approximately 250 feet deep in the accretion zone of the Snohomish River delta in Port Gardner. This document discussed dredging limits; descriptions and quantities of debris, contaminated and clean sediments; dredging and disposal equipment and procedures; cost estimate; and dredging and disposal plan. The 35% Basis of Design was the preliminary project information given to the U.S. Army Corps of Engineers for commencement of testing, modeling and evaluation provided by WES as technical assistance to the U.S. Navy Homeport design effort.

3.2. Dredging Plan

3.2.1. East Waterway Dredging Plan

The Navy program for development of the proposed Homeport at Everett requires a number of water-oriented construction activities:

- o demolition of existing piers, pilings and structures;
- o subsequent construction of breakwater, mole and piers;
- o dredging of East Waterway to accommodate planned vessel use and to expose suitable foundation for breakwater/mole construction.

For reference, East Waterway is divided into two general areas: the inner harbor, essentially within (north of) the existing marginal wharf and the remaining outer harbor. Water-oriented construction has been separated into three major projects for federal funding

purposes. The project limits are identified in Figure 2-4 and include:

- o P-111 Outer Harbor Dredging, Breakwater and Mole
- o P-905 Outer Harbor Dredging, Second Increment
- o P-112 Dredging Inner Harbor

Funding for the three projects has been tentatively programmed for FY 1987 (P-111) and FY 1988 (P-905 and P-112). Funding will guide sequencing of the construction and dredging projects. Dredging for the Homeport project requires removal of a total of 3,305,000 cubic yards of sediment from the inner and outer harbor portions of East Waterway. The purpose of sediment removal is to provide the required depths of 42, 50, and 55 feet MLLW for vessel handling, and to expose a suitable foundation for construction of the breakwater, carrier, pier and mole. The general dredging plan is also shown in Figure 2-4.

Early field exploration identified that much of the harbor dredging area is overlain by a substantial deposit of contaminated organic sediment and debris. An extensive field program was undertaken to characterize and test the sediments to be removed from East Waterway. This included seventy-eight core samples taken throughout the dredging area during the period of July 1984 to August 1985. Additional data was collected using side-scan sonar mapping and field inspection of the bottom sediments by divers. Based on sampling results, harbor sediments to be removed are characterized in terms of debris, contaminated layer and remaining native (relatively clean) soils (ABAM, 1985).

3.2.1.1. Debris

The debris, consisting mostly of logs and metal, lies at or near the sediment surface layer which is estimated to be 0 to 4 feet thick. Logs range from 6 to 48 inches +/- in diameter and 10 to 60 feet in length; condition varies from solid to badly deteriorated or decayed. The log debris exists as piling, individual loose logs, jumbled masses, orderly stacks or bundled with cable. Additional debris includes wire rope, chain, steel plate, ship or barge hulls, tires, piping, and other miscellaneous material.

3.2.1.2. Contaminated Soil

The contaminated soil consists of the upper layer of harbor sediment ranging from 0 to 7 feet in thickness. It is comprised of fine grained, black to dark brown, odorous surface sediment including abundant wood fragments, chips and sawdust. The contaminants include oil and grease, heavy metals, polyaromatic hydrocarbons (PAH), and polychlorinated biphenyls (PCB) (ABAM, 1985).

Extensive laboratory testing (Appendix B of the DEISS) has shown that contamination levels in these sediments are well below any

concentration associated with hazardous waste designation under RCRA or related state Dangerous Waste requirements (Chapter 173-303 WAC). However, certain contaminant levels do exceed background levels in Port Gardner and, to a lesser extent, biological effects thresholds observed elsewhere in Puget Sound (Tetra Tech, 1985); therefore, capping of the contaminated sediments is proposed as a means to isolate them from surrounding waters. RCRA does not apply to the disposal of dredge material.

The disposal of dredge materials does not fall within the purview of the Resource Conservation and Recovery Act (RCRA). The Act definition of hazardous waste was used for purposes of comparison only.

3.2.1.3. Uncontaminated Soil

The uncontaminated soils underlie the contaminated sediments in the harbor area north of the south mole and in limited areas east of the carrier pier. They are generally at the surface south of the south mole and west of the carrier pier. They range in thickness to greater than 50 feet and are comprised mainly of native materials in the form of gray and brown sandy silt. Some organic material and wood fragments/chips are present in small amounts in certain areas. Chemical and biological analyses have shown that these sediments meet requirements for unconfined open water disposal in Port Gardner.

3.2.2. Dredging Quantities

Both laboratory testing and physical inspection of core samples have shown that the contaminated layer is separated from the cleaner native materials by a visible contact zone. This is typified by the transition between the darker gray and brown to black odorous contaminated sediments including abundant wood particles, and the lighter colored sandy silt of the underlying native sediments. The depth of the contact zone delineating the thickness of the contaminated layer was recorded for core samples and provides the basis for describing the areal extent, thickness and volume of the contaminated layer.

To provide a basis for project planning, it was necessary to differentiate between contaminated and clean sediments for dredging and disposal purposes. Following completion of the core sampling and testing effort in the project area, a criteria for designating contaminated sediments was established by Seattle District (Otten, 1985). The contaminated soil was identifiable by the darker brown and blacker coloring, a strong odor and abundant wood chips and lying above the contact zone with clean sediments. To assure that all contaminated sediments are separated from the clean sediments it is proposed that dredging of the contaminated sediments would include a 1 foot overdepth beneath the identifiable criteria limit. This is based on test results that indicate leaching of

contaminated materials into the upper one foot of clean sediments may have occurred at various locations, and that the actual dredging operation will have to over-excavate to insure that all contaminated sediments are removed. A typical cross-section of the harbor showing the general relationship of contaminated sediment and clean materials to the dredging configuration is shown in Figure 3-1.

Calculation of sediment volumes by project has been completed. Table 3-1, Navy Homeport Dredge Quantities, provides a summary of those values (ABAM, 1986). The sediment volumes were computed by the double end area method, using cross sections developed on 50 foot stations.

The "In Situ Contaminated" volume represents the minimum neat line quantity of sediments that includes all of the contaminated as defined above (Black, strong odor, wood chips above the contact zone) plus one foot minimum overdepth below the criteria limit to account for potential leaching and to assure its removal during dredging. The "Dredge Contaminated" represents a modified dredging plan that is more practicable and requires some precision dredging operations to assure that all contaminated sediments are removed during the contaminated dredging phase of the work. The "Dredge Clean" is the volume of clean sediments remaining after dredging the "Dredge Contaminated" volume including a 1-foot overdepth allowance. The "Total" is the sum of the "Dredge Contaminated" and "Dredge Clean" values.

It should be noted that the final sediment volumes shown in Table 3-1 vary from those reported in the FEIS (Navy, 1985), which were based upon nineteen core samples collected in July 1984 and from interim calculations supplemented by 20 additional core samples collected in February 1985, intended to better define sediment contamination and biological effect. Subsequently, in August 1985, 25 additional core samples and side-scan sonar surveys were collected using the piston-core method, which minimizes sediment sample distortion. The revised calculation of 928,000 cubic yards of contaminated sediment to be removed from East Waterway is based upon composite information from all samples and includes a minimum overdepth dredging to two feet, i.e., one foot minimum below the criteria limit for contaminated soil plus one foot of overdepth dredging tolerance.

Actual dredging equipment anticipated for the sediment removal, such as a large bucket dredge, may not have the capability to dredge consistently within a one foot tolerance of required neatline depths identified in Figure 3-1. This fact has been noted, and the impact of over-dredging the contaminated layer has been analyzed. Calculations based on over-digging of contaminated sediments have been completed to assure a strategy for obtaining adequate capping materials for all alternative designs. Under-

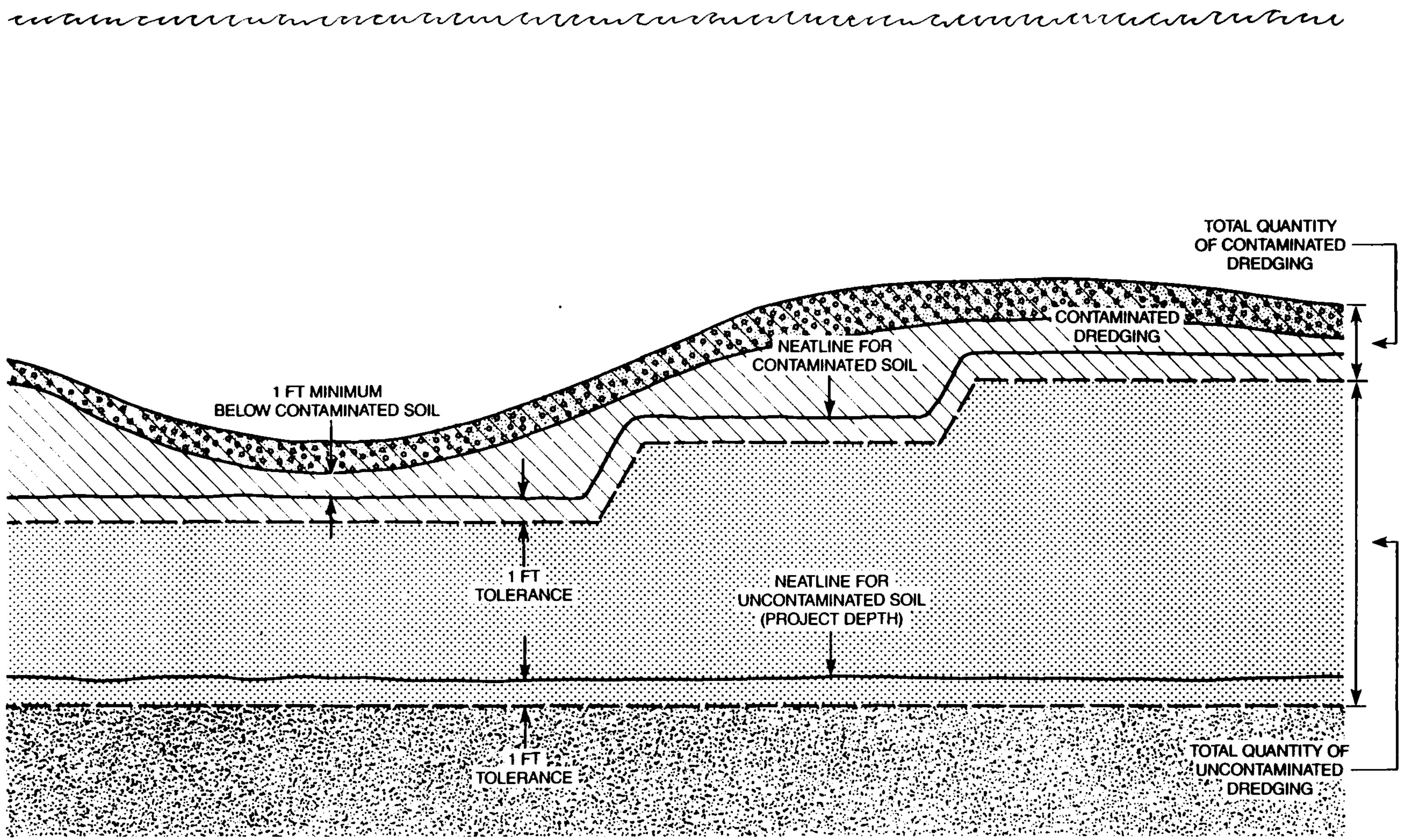


Figure 3-1.
Typical dredging section, East Waterway.

digging of the contaminated and the clean sediment layers will not be accepted.

An additional 54,500 cubic yards of "Dredge Contaminated" sediments exists in the project P-112 area, but below the project depths.

The removal of these remaining contaminated sediments will be considered in the overall dredging of the project as a means to provide additional improvement to East Waterway.

The amount of surface debris for removal prior to sediment dredging is estimated at 52,000 tons (ABAM, 1986). This is based on results of side-scan sonar mosaics.

3.2.3. Contaminated Sediment Characterization

Extensive sampling and analysis of East Waterway sediments has taken place in order to determine the physical and chemical composition of the sediments, the degree of contamination, the depth of the contaminated zone, and the behavior of the sediment, especially as it affects water quality and bioassay parameters, during dredging and disposal. The U.S. Army Corps of Engineers, Seattle District (NPS), and Waterways Experiment Station (WES) at Vicksburg, Mississippi, provided major technical assistance for these investigations.

The technical assistance program was carried out in three phases. Phase I, completed in February 1985, identified the presence, extent, and nature of chemical contaminants in East Waterway sediment and identified approximately 840,000 cubic yards of sediment as unacceptable for unconfined disposal in Puget Sound. As discussed above, this estimated volume has been refined by additional data (U.S. Army 1985a). Phase II, completed in May 1985, focused on biological testing of the relatively uncontaminated marine sediments underlying the contaminated layer. In addition, the physical, chemical, and biological character of eight aquatic and nearshore locations in Port Gardner were tested for their potential as confined disposal sites for East Waterway sediments (U.S. Army 1985b). Phase III technical assistance involved comprehensive testing of East Waterway sediments using a series of tests and decision making framework developed by WES and the Seattle District (Lee et al., 1985)); and numerical modeling by WES for the contaminated disposal alternatives, biological studies, and development of guideline criteria for dredging and disposal (Appendix B of the DEISS).

The comprehensive Phase III studies conducted by WES was included in the 1986 Seattle District Report Dredging and Disposal Design Requirements (U.S. Army, 1986a). This report is a major reference for the following discussions of information developed since the Navy FEIS and is Appendix D of the Draft EISS.

Previous sampling and analyses of East Waterway sediments (U.S. Army, 1985a, 1985b) indicated that contaminant levels were similar throughout the volume of contaminated sediments. In consultation with state and federal agencies, the Seattle District, U.S. Army Corps of Engineers, determined that a composite sample representative of the entire contaminated sediment volume would be collected and subjected to a comprehensive series of physical, chemical and biological tests as a basis for all Phase III studies. On June 6, 1985, a total of eight cubic yards of sediment was collected throughout the contaminated layer, thoroughly mixed (homogenized) and shipped to WES in Vicksburg for testing. Representative reference samples of the native sediments and seawater from the harbor were also collected for this evaluation.

Use of a representative composite sample as the basis for project design recognizes the contamination of any given sample may either exceed or be cleaner than the composite results. This potential bias is reasonably offset by two factors:

1. Significant mixing, i.e. compositing, will actually occur during construction by the nature of dredging and disposal activities. This is particularly true for hydraulic dredging and disposal to nearshore or upland sites. Higher contamination levels will be diminished by such mixing.

2. As described in section 3.2.2, Table 3-1, the "dredge contaminated" volume of 928,000 cubic yards to be removed and treated as contaminated material includes a volume of underlying uncontaminated material approximately equal to the "in situ contaminated" volume of 486,900 cubic yards. Consequently, the overall average contaminant concentration of the "dredge contaminated" volume is substantially less than that of the U.S. Army Corps of Engineers composite sample which is representative of only the in situ layer and used as testing and design basis.

Results of the WES tests on contaminated sediment are summarized below and fully reported in Appendix B of the DEISS.

3.2.3.1. Physical

A physical and engineering characterization of the homogenized composite contaminated sediment sample was conducted by WES Geotechnical Laboratory. The characterization consisted of natural water content, specific gravity, Atterberg limits, grain size distribution, and Unified Soil Classification. The sediment was described as a black, sandy, organic silt. Test results are summarized in the following tabulation:

Water Content	157%
Specific Gravity (solids)	2.44
Percent Passing #200 Sieve	88%
Liquid Limit	116%
Plastic Limit	57%
Plastic Index	59%
USCS Classification	(OH)

3.2.3.2. Chemical

The Everett composite sample of contaminated sediments and a sample of the underlying native sediment sample were chemically analyzed by WES to establish a reference for the extensive mobility tests to be performed and to develop a selected list of compounds to be tracked during the testing. Subsamples of the composite and native sediments were concurrently provided to the PNL facility at Richland, Washington for separate chemical and biological testing. This was done to maintain the continuity of analyses by having the same laboratory perform same analyses on composited sediments as had been conducted on prior individual sediment samples. Results of the PNL testing were reported in Anderson and Crecilius (1986). It was concluded that the concentration of contaminants in the composite was representative of the more contaminated sediments previously encountered (U.S. Army, 1985a, 1985b).

Based on the results of this analyses, a list of selected representative parameters or specific compounds was developed for the study by consultation between WES and the Seattle District, U.S. Army Corps of Engineers. The resulting identified parameters of concern are: chromium (Cr), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), lead (Pb), cadmium (Cd), mercury (Hg), selected polychlorinated biphenyls (PCB's) and polynuclear aromatic hydrocarbons (PAH's), and 1- and 2- methylnaphthalene (a total of 32 specific parameters, as included in Table 3-2).

The dredging site water sample was also analyzed for the parameters of concern. Results are shown in Table 3-2. All parameters were below detection in the site water sample except for Cu, Ni, Cd, Cr and Hg. The site water concentrations equaled or exceeded the Federal water quality criteria (USEPA, 1980) for the protection of salt water aquatic life for Cu, Ni and Hg. It is noted that this sample was taken from near-bottom waters within East Waterway and may contain elevated contaminant levels representative of the Harbor. Consequently, it is not representative of open waters in Port Gardner or the Snohomish River.

3.2.3.3. Standard Elutriate Test

This test is used to estimate the amount of dissolved contaminant release chemically transferred from the contaminated sediment to the receiving waters during a dredging/disposal operation; it does not consider the effects of dilution or mixing. Standard elutriate

Table 3-2. Everett Harbor Site Water Chemistry[1]

Parameter	Concentration ppm
Arsenic	<0.005
Copper	0.007
Nickel	0.007
Cadmium	0.0006
Lead	<0.001
Zinc	<0.030
Chromium	0.004
Mercury	0.0067
PCB-1016	<0.0002
PCB-1221	<0.0002
PCB-1248	<0.0002
PCB-1232	<0.0002
PCB-1254	<0.0002
PCB-1242	<0.0002
PCB-1260	<0.0002
Acenaphthylene	<0.005
Naphthalene	<0.005
Acenaphthene	<0.005
Fluorene	<0.005
Fluoranthene	<0.005
Phenanthrene	<0.005
Pyrene	<0.005
Benzo (B) Fluoranthene	<0.005
Anthracene	<0.005
Chrysene	<0.005
Benzo (K) Fluoranthene	<0.005
Benzo (A) Pyrene	<0.005
Benzo (G H I) Perylene	<0.005
1-Methylnaphthalene	<0.005
Indeno (1 2 3-C D) Pyrene	<0.005
2-Methylnaphthalene	<0.005
Dibenzo (A H) Anthracene	<0.005

Note: Concentrations of this Everett Harbor site water sample were specified by the Seattle District for use as Port Gardner background or reference.

1. From: U.S. Army Corps of Engineers, 1986a. Dredging and Disposal Design Requirements Report

tests were run using the composite sediment and the harbor reference water samples. In the laboratory, appropriate portions of sediment and water are mixed and allowed to settle. Supernatant water is analyzed for chemicals and compared with the reference water to determine the amount of contaminant released from the sediment. Results can be used to estimate the degree of dissolved contaminant release to receiving waters at a CAD site. Procedures and detailed results are presented in Appendix B.

A measure of the potential impact of chemical contaminants released to receiving waters is compared to allowable Federal Water Quality Criteria for protection of aquatic life (USEPA, 1980). These Federal Water Quality Criteria give allowable contaminant concentrations for both fresh and salt water in terms of both acute and chronic protection values. Acute values represent the maximum level of contaminant which must not be exceeded at any time to protect sensitive aquatic life (acute toxicity). Chronic values are those which may be toxic to sensitive organisms over a 24-hour period of exposure (chronic toxicity). Allowable acute (maximum) levels are generally higher than chronic exposure limits, but for some toxicants, e.g., PCB, the two values may be equal. Comparison of Federal Water Quality Criteria with projected chemical concentration levels in receiving waters resulting from dredging/disposal provides a basis to evaluate potential water quality impacts, mixing zone requirements and control measures. It is noted that the Federal Water Quality Criteria also provide the basis for applicable State of Washington Water Quality Standards.

Results showed that 7 of 33 contaminants of concern were detected in the elutriate tests. Five of these parameters exceeded background concentration in the reference water: Ni, Cd, Pb, Cr and PCB 1254. Both Cd and Cr are below both the chronic (24-hour) and acute (maximum) exposure values given in the Federal water quality criteria (USEPA). The remaining parameters of concern are Ni, Pb and PCB 1254.

Minimum dilution factors necessary to reduce contaminant concentrations to meet criteria levels may be estimated using procedures given in the document Decision Making Framework for Management of Dredge Material (Lee, et al., 1985).

Lead (Pb) concentration slightly exceeded chronic exposure values given in the Federal Water Quality Criteria. A calculated dilution factor of less than one is required to reduce Pb values to meet criteria.

PCB 1254 concentrations exceeded both chronic and acute exposure values in Federal Water Quality Criteria. A calculated dilution factor of 13 is needed to reduce concentration to criteria levels.

Nickel (Ni) concentration in the elutriate was about twice the chronic exposure level given by the Federal Water Quality Criteria,

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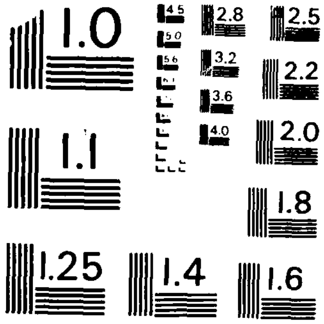

MICROCOPY RESOLUTION TEST CHART
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but was far below the acute exposure value. It is noted that Ni concentration in the Harbor reference water equalled the chronic criteria level; therefore, the chronic criteria levels cannot be met for Ni by dilution with the reference water sample from the Harbor. However, both Snohomish River and Port Gardner water would be expected to contain less Ni concentration and, therefore, provide dilution opportunity to meet chronic criteria levels.

The estimated dilution factors of one (Pb) and 13 (PCB 1254) to reduce contaminant levels to meet Federal criteria for chronic exposure are considered minimal and should be achievable by dispersion and mixing within a short distance of an open-water disposal site. For this reason WES concludes that, "Based on these data, there appears to be no need for controls from the standpoint of contaminant release in the dissolved form during placement of the sediments for the CAD alternative" (see Appendix D of the DEISS).

3.2.3.4. Modified Elutriate Tests

These tests were conducted by WES to predict the quality of effluent discharged from a typical disposal retention pond for hydraulic pipeline dredging activities. These tests define both the dissolved and the particle-associated concentration of contaminants in the effluent and account for the settling behavior of the dredged material, retention time of the containment area, and chemical environment in ponded water during active disposal. Detailed procedures and results are presented in Appendix D of the DEISS.

The dissolved portion of the modified elutriate test results were compared with background (Harbor reference sample) water quality and the Federal Water Quality Criteria. Five of the 32 contaminants of concern were detected. Only Ni and PCB 1254 exceeded background values.

Dissolved Ni exceeded the chronic exposure level but was far below the acute exposure value given by the water quality criteria. As described for Standard Elutriate tests (above), Ni cannot be diluted to below the chronic criteria by mixing with the reference water because the Ni value for the reference water equals the chronic criteria for Ni.

Dissolved PCB 1254 exceeded the chronic and acute exposure value (single value) given by the Federal Water Quality Criteria. Using established procedures (Lee, et al., 1985), a dilution factor of 13 is calculated as necessary to dilute PCB 1254 concentrations to meet the exposure criteria. Although actual dilutions are dependent on site-specific factors, a dilution factor of 13 is considered minimal and readily achieved by proper design.

The modified elutriate test accounts for contaminant concentrations associated with both the dissolved and suspended solids discharged in the effluent. Calculation of the "mass release" of contaminants in the effluent is therefore possible if dredging and disposal site settling characteristics are known. An estimate of mass release for representative confined disposal conditions was made, assuming use of a 24-inch dredge and a 100 acre confined disposal site. Calculations were made for only those parameters which were detectable in the modified elutriate tests. Mass release of all contaminant parameters was less than 0.6 percent except for PCB with a mass release of 3.2 percent. This means, for example, that 3.2 percent of the PCB mass dredged and disposed would be lost back to the receiving waters in the effluent from the assumed settling pond.

3.2.3.5. Settleability

Settling tests were run by WES to define the sedimentation characteristics of materials to be dredged. Using the methods of Palermo, et al. (1978) sediment samples were slurried to sediment-water concentrations representative of field hydraulic (pipeline) dredging conditions. The slurried sediment-water mixture was allowed to settle in an 8-inch diameter column in the laboratory. The depth of the progressing sediment-water interface and the distribution of suspended solids in the resulting overlying water column were measured and recorded over time. These results were used to design the settling pond area for hydraulic dredge nearshore and upland disposal controls and to predict suspended solids concentrations in the pond effluent resulting from gravity settling. Detailed methods and results are presented in Appendix D of the DEISS.

Test results showed that settling behavior of East Waterway sediments at slurry concentrations expected in pipeline dredging was governed by a zone-settling process. In zone-settling, the sediments exhibit a distinct interface between the settling materials and the overlying clarified water (supernatant). This is typical of salt water conditions. Tests were conducted for up to fifteen days to fully describe the zone and flocculent settling of fine particles in the supernatant. There was no significant difference in settling characteristics for East Waterway sediments with wood chips present or with wood chips removed. This database was used to define confined disposal site geometry necessary for effective sedimentation and effluent control.

3.2.3.6. Capping Effectiveness Test

WES used a small scale reaction column to predict the cap thickness required to chemically isolate contaminated Everett Harbor sediment from the overlying water column in confined aquatic disposal (CAD). Dissolved oxygen depletion rates and release rates of ammonium-nitrogen, and orthophosphate-phosphorus, were used as tracers in

the predicted test. In this test, ammonium-nitrogen and orthophosphate-phosphate proved to be the best tracers. Detailed methods and results are presented in Appendix D of DEISS.

An early result of these tests showed that there was no significant difference between the dissolved oxygen depletion rate of contaminated Everett Harbor sediment and the underlying relatively clean native sediment used for capping; these rates were 628 mg/m2/day and 635 mg/m2/day, respectively. This tends to indicate that uncapped contaminated sediment exposed during construction of deep CAD would not deplete the oxygen resources of overlying seawater at the site significantly more than for the capped condition.

The small-scale predictive tests indicate that clean native Everett Harbor sediment is effective in isolating contaminated Everett Harbor sediment from the water column. Increasing cap thickness retarded the release of ammonium-nitrogen and orthophosphate-phosphorus tracers from the sediment to the overlying water. The ability to retard or prevent the movement of these reduced chemical constituents is used as an indicator of cap effectiveness because these particular species are much more mobile than most chemical contaminants associated with sediment. For Everett Harbor contaminated sediment with a native sediment cap, the minimum effective cap thickness was 30 cm. To prevent exposure of burrowing benthic organisms to contaminated sediment, it is recommended that a safety margin be added to the thickness required to achieve a chemical seal. This safety margin is determined by assessing the depth reached by the deepest burrowing benthic organism within the region. The geoduck clam is reported to be the deepest burrowing organism in Puget Sound. To reduce potential exposure of deep burrowing organisms to the contaminated sediments, a 50 centimeter bioturbation safety factor was added to the 30 cm. cap required for chemical isolation. Overall a 1 meter (approximately 3.3 feet) cap was recommended as an operational requirement to insure at least 80 cm. minimum cap across the site. This thickness does not take into account any additional material that may need to be added to allow for erosion or any other physical factors present in the environment. Actual design for the capping thickness is using a safety factor of 1.4 to assure a conservative cap design. This will provide a 1.4 meter thickness for the cap.

3.2.3.7. <u>Surface Runoff</u>

Tests were run to predict surface runoff water quality and associated contaminant losses due to rainfall and runoff from a confined upland or nearshore contained dredged material disposal site. The tests were conducted using the WES Rainfall Simulator-Lysimeter which has proved effective for similar tests of dredged material runoff elsewhere. Approximately 2,000 liters of contaminated sediments were placed to a depth of about 33 cm on the lysimeter bed. Simulated rainfall storm events were applied to both the initial wet condition and again after about 6 months of

natural drying and oxidation. Runoff water samples were collected during each rainfall event and analyzed for suspended and dissolved (unfiltered and filtered) contaminants. Results describe expected contamination of surface water runoff from an exposed (uncapped) nearshore/upland disposal site for East Waterway contaminated dredged materials. Detailed methods and results are presented in Appendix B of the DEISS.

Dredge material removed from East Waterway will be anaerobic with a pH of about 8.0. Most contaminants, including heavy metals, are tightly adsorbed to the sediment solids and are not bioavailable. Therefore, removal of solids (by settling, stabilization) removes the contaminants. As the surface sediments dry in-place in the fill and become oxidized, the pH lowers to about 7 and metals become slightly more dissolvable in the surface runoff. Also of note, East Waterway contaminated sediment did not fully dry and compact, as do more typical fine-grained dredged sediments; instead, because of the high organic content, it forms a light fluffy surface layer which was highly erodible with rainfall.

For the initial wet condition, test results showed that dissolved heavy metals were below the Federal Water Quality Criteria for protection of aquatic life and PCB's were below levels of concern. Suspended solids in the runoff did carry low levels of contaminants; these can be removed by providing settling of the runoff waters prior to discharge from the disposal site.

For the matured (dry/oxidized) condition, suspended solids concentrations were high in the runoff due to erosion of the uncompacted surface sediments. Resulting contaminant levels for Cd, Zn and Cu were high for both the unfiltered and dissolved stages. Of these, Cd exceeded Federal Water Quality Criteria by the greatest amount and requires a calculated dilution factor of 18 to reduce its concentration to criteria levels. PCB's were below detectable levels in the runoff, and PAH values were low.

Based on these results the following conclusions are reached:

- Suspended solids concentrations will be high in surface water runoff from exposed contaminated dredged disposal for both the wet (initial) and dry (matured) condition. The suspended solids will carry contaminants and, therefore, surface waters should be contained for removal of suspended solids by settling prior to discharges.

- After dredge deposition, dissolved contaminant concentration in surface runoff from exposed contaminated sediments for Cd, Zn and Cu may equal or exceed Federal Criteria for protection of aquatic life. An estimated dilution factor of 18 is required or runoff treatment must be provided in order to reduce dissolved maximum contaminant concentration to criteria levels.

The preferred method of containing contaminants in an exposed dredged disposal area is to provide a surface cover of clean and stable materials to isolate contaminated sediments from surface runoff. Such cover materials may be planted or developed in other ways to increase its stability and contoured to minimize surface water infiltration or erosion.

3.2.3.8. Leachate

When contaminated dredged material is placed in a confined near-shore or upland disposal site it may potentially generate contaminated leachates as groundwater moves through the sediment and dissolves contaminants. At present, there is no routinely applied laboratory testing protocol to directly predict leachate quality from dredge disposal sites.

WES has developed experimental testing to provide a laboratory basis for estimating leachate generating capability of contaminated sediments. The tests essentially involve passing water through contaminated sediments in a controlled laboratory environment and measuring the resulting quality of generated leachate referenced to related changes in sediment contamination levels. Laboratory results may be used with groundwater flow theory to evaluate potential leachate impacts for a given disposal site.

Two types of tests were conducted. Batch testing measured generated leachate concentrations compared to remaining sediment concentration as sequential volumes of clean water are washed through the sediment. The resulting relationship between the sediment contaminant level and the leachate concentration it generates may be used to mathematically describe the chemical transfer process affecting a specific dredge disposal material and site.

Because batch tests do not duplicate actual flow and dispersion effects, a second test using a continuous flow column permeameter is conducted to provide an integrated measure of leachate generation over time. In the permeameter test, clean water is continuously percolated through the known sediment and the resulting leachate concentrations are monitored. Results of the batch test are then used with the permeant porous-media equation to predict leachate generation over time for comparison with actual results of the continuous flow permeameter test. To the extent that the porous-media equation predicts observed leachate generation the laboratory results may be used to mathematically evaluate expected leachate impacts for the field condition of contaminated dredged material disposal. Detailed methods and results to date are presented in Appendix B.

Leachate testing performed on East Waterway contaminated sediments indicates that there is a potential leachate mobility of heavy metals and organic contaminants, but the potential remains low

under anaerobic conditions. This is primarily related to pH of the sediments; oxidized (aerobic) sediments from East Waterway were observed to be lower pH than found in the insiter saturated (anaerobic) condition. The majority of metals in the anaerobic sediment are tightly bound to the sediment solids with the fraction of metals resistant to leaching generally greater than 90 percent of the bulk concentration. Cd and Pb batch leaching concentrations slightly exceed Federal drinking water standards, suggesting a potential problem if there is no attenuation of contaminants by underlying soils or dilution of the leachate by surface or ground water. Violations of drinking water standards would be predictable only if there is direct exposure of ground water to concentrated, undiluted leachate.

Under aerobic conditions, over 85 percent of sediment Zn, 56.7 percent of sediment Ni, and 49.1 percent of sediment Cd were mobilized. Only minor amounts of other metals were released under aerobic conditions. Aerobic batch leaching concentrations significantly exceeded drinking water standards for Zn, Cd, and Pb. This indicates that final design of upland alternatives which are susceptible to progressive oxidation/aerobic conditions will be preceded by site-specific evaluations referenced by actual groundwater and long-term leachate testing results.

3.2.3.9. Sediment Stabilization

A potential technique for immobilizing contaminants, providing a disposal site liner, and improving the engineering properties of dredged material is solidification/ stabilization. Solidification/ stabilization involves the addition of a setting agent(s) to the dredged material. Various setting agents have been used to treat industrial wastes and flue gas desulfurization sludges. These include cement, lime, kiln dust, blast furnace slag, sodium and potassium silicates, and various combinations of these materials. The resulting product has improved engineering properties (lowered permeability and increased bearing capacity) and reduced contaminant mobility.

WES conducted a series of tests on a limited number of stabilization techniques to determine improvements in compressive strength and chemical leachability. Additives tested were portland cement, fly ash, lime and Firmix (a commercially available, proprietary solidification agent). Various strengths and combinations of additives were thoroughly mixed in the laboratory with proportions of East Waterway sediments and cast into molds for setting and testing. Detailed methods and results are presented in Appendix D of the DEISS.

The unconfined compressive strength (UCS) was determined according to ASTM methods for hydraulic cement mortars at cure time intervals of 7, 14, 21 and 28 days. Some formulations were tested for 60 and 90 day cure times. A fly ash/lime process produced the lowest UCS

and a portland cement/Firmix process produced the highest 28 day UCS. The range in 28-day UCS was 7 pounds per square inch (psi) to 605 psi, depending on the agent(s) used for solidification and the dosage applied. The maximum strength recorded was 1176 psi at 90 days. This range in product strength is indicative of the versatility of solidification as a physical stabilization process for East Waterway sediment. The technology has the flexibility to meet specifications for physical stability ranging from primarily immobilizing sediment solids in low strength product to producing a material suitable for end uses typical of soft concrete.

Chemical testing showed that solidification/ stabilization reduced the leachability of selected metals. Arsenic and zinc were completely immobilized by the processes tested to date. Cadmium concentrations in the leachate were in the same range as or slightly above unexposed sample blanks. Most (99 percent) of the chromium and lead in the solidified/stabilized sediment was resistant to leaching. Thus, the limited data available indicates that solidified/stabilized Everett Bay sediment does not have a significant leaching potential for metals.

3.3. Dredging and Disposal Equipment and Methods

Dredging equipment has been developed over the years for two basic purposes: the excavation of channels for the purposes of aiding navigation and the winning of material for mining or land reclamation purposes. For these purposes, both hydraulic and mechanical types of dredging equipment have been developed. Mechanical equipment excavates material by mechanical means such as a clam shell or drag line bucket. Material is usually deposited in barges and hauled to in-water disposal sites where it is dumped or rehandled to an upland site. Hydraulic dredging equipment is generally either of the hopper or pipeline type. Both use centrifugal pumps to load a slurry of water and bottom sediments. Hopper dredges carry this material on board to either an in-water disposal site for dumping or an upland site where material is pumped ashore. Pipeline dredges deliver material to the disposal area by pumping the slurry through a discharge pipeline to the destination. Both mechanical and hydraulic pipeline dredges have been considered for use on the proposed homeport project.

The dredging process consists of four basic steps: loosening material from the bottom, lifting material to the surface, moving the material to the disposal area and disposing of the material.

During the dredging operation the clamshell dredge can deliver sediments in a near "in situ", less disturbed, condition than the pipeline dredge operation. The "clumpiness" of the clamshell sediments allows the disposal operations to be more predictable, with sediment fate more easily controlled. This becomes more of a consideration when the disposal site is an in-water site such as confined aquatic or open water disposal in Port Gardner. The use

of a pipeline dredge to remove contaminated sediments would be more appropriate in conjunction with a nearshore or upland contained disposal site. The different types of equipment to be utilized for each dredge disposal site alternative are discussed later in this study.

A large volume of debris is expected throughout the contaminated layer. The debris will be removed concurrently with dredging by use of a barge-mounted crane and clamshell. Debris will be deposited onto a separate flat deck barge, and subsequently offloaded and disposed to an approved upland site.

3.3.1. Mechanical Dredge Operations

The clamshell dredge is the most likely of the mechanical dredge types for use on this project (Figure 3-2). The dredging unit consists of a barge mounted crane of sufficient size and rating to cast a large clamshell bucket. The open bucket is dropped to the bottom and closed, thus enclosing an amount of material roughly equal to the size of the bucket. The sediment-filled bucket is then raised to the surface by means of wires. The bucket is then swung over a hopper type barge, opened and its contents dumped into the barge. When the barge is full, it is pushed or pulled by a tug boat to the disposal area. Conventionally, disposal takes place by opening bottom doors or hull (in the case of split hull type barges). Alternatively, material can be rehandled to a downpipe for delivery closer to the bottom. For disposal on shore, material is generally rehandled by another crane-mounted clam shell, loaded to trucks, and transported to its final destination. In the case of a large volume fill, truck delivery at the disposal site could be difficult because the material may be too wet to drive on but not wet enough to flow and provide a level fill.

The dredged materials in the barges will be close to in situ density with very little water added in the dredging process. However, it must be remembered that the silty in situ surface material already has a significant water content as identified in Section 3.2.3.1. Disturbance of the surface layer during removal of debris will also tend to loosen the material and add water.

3.3.2. Hydraulic Pipeline Dredge Operations

The hydraulic pipeline dredge is efficient for the movement of a large volume of sediment as a slurry to an intertidal or upland disposal site (Figure 3-3). The sediment is loosened from the harbor floor by a rotating cutterhead, raised to the surface as a slurry, and pumped through a discharge pipeline to the disposal site. As a result, the sediment slurry does not come in contact with the water column during the dredging and transport phase of the work. A small amount of material is resuspended by the cutter head but would be expected to settle nearby. The disposal opera-

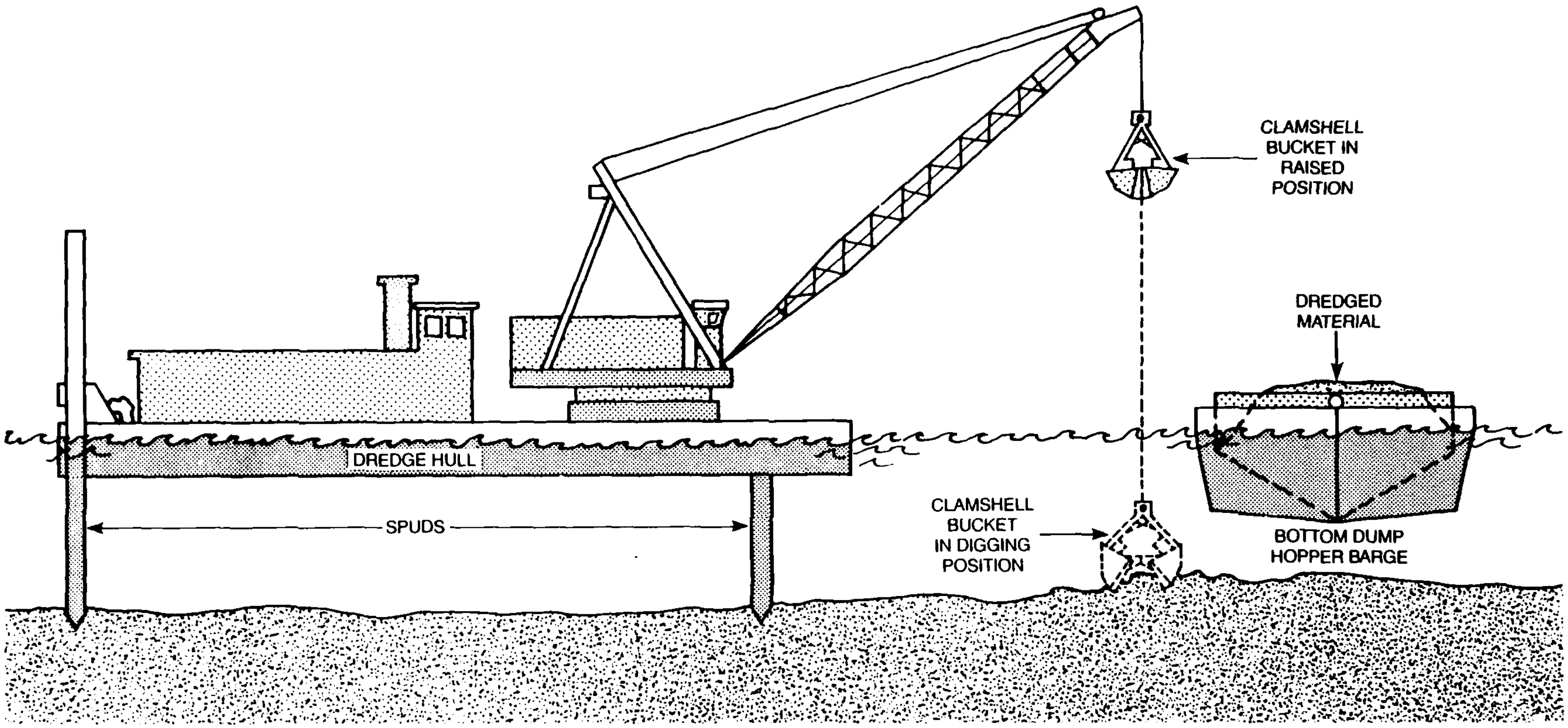

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Figure 3-2.
Bucket dredge with bottom dump barge.

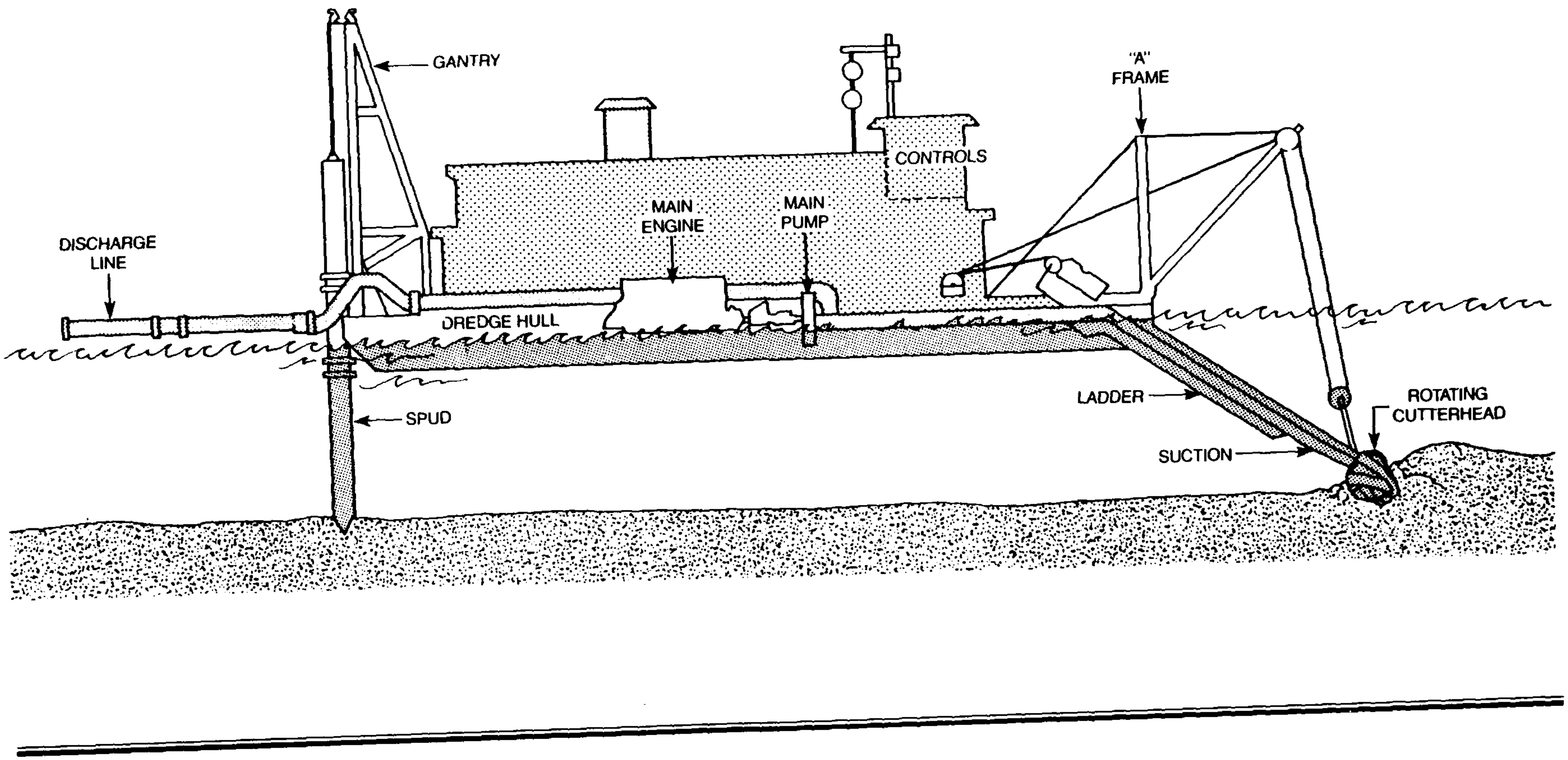

Figure 3-3.
Hydraulic pipeline cutterhead dredge.

tion must be considered carefully to evaluate the water quality impact and fate of the sediments.

The slurry arrives at the disposal site as a typical mix of 5 percent to 25 percent in situ solids. The rate of material delivery to the site is a function of the dredge pipeline diameter, dredge horsepower and other factors. This rate of delivery is a major consideration in the design of adequate control measures for water quality. For example, when considering intertidal or upland disposal, diked disposal areas must be designed with adequate spillways and sufficient retention capacity to allow the slurry adequate ponding time. The ponding allows the solids to come out of suspension before the water is returned to the receiving waters.

3.3.3. Other Types Of Dredging Equipment

Several other types of dredges were to be considered for use on the project in the event some exceptional control of contaminated sediments was deemed necessary. Seagoing, self-propelled, hydraulic hopper dredges were considered but concluded to be inappropriate due to the configuration of the dredging cut and the lack of maneuverability. High density, air driven dredges such as the "Oozer" or "Pneuma" systems were considered to be inappropriate due to their low production rates and lack of power to move sediments over long distances. However, these air driven types of dredges could be considered for rehandling material from barges to upland or intertidal disposal areas to avoid the potential fill problems with trucks as noted above. The equipment identified was selected based on the sediment test results, ability to safely excavate contaminated sediments and relative schedule and cost efficiency.

3.3.4. Dredge Production Rates For Project Planning

Dredge production rates will be sensitive to selection of disposal areas, specified disposal methods and constraints imposed on dredging and disposal techniques. For the 35 percent design submittal, daily dredging rates of 6,200 cubic yards and 20,000 cubic yards were used for clam shell and pipeline dredges, respectively. While these figures are considered adequate for planning and scheduling purposes, there is equipment available that could achieve greater production figures assuming the specifications allowed the methods of operation and capacities necessary to obtain maximum production. This is important for upland fills, and possibly for submerged fills, because the production rates of the dredges may have to be constrained to avoid water quality or vertical stability problems with the fill.

3.3.5. Disposal of Material

Disposal methods are highly dependent on the disposal site conditions such as slope, area, and the type of dredging equipment

selected. For mechanical dredges, the most common method of disposal is dumping in open water by means of a bottom dump barge (Figure 3-4). These barges range in size from 500 cubic yards up to 4,000 cubic yards and larger. Dumping mechanisms include both bottom-doors and split- hull type barges. The latter type of barge actually splits down the middle allowing an almost instantaneous discharge of the material. Tests have shown that material disposed of by dumping tends to remain more or less intact and falls to the bottom as a mass at a high rate of speed. After impact, the material breaks up and its ultimate dispersion is highly dependent on ambient currents and bed slope at the point of impact. Modern electronic positioning equipment will be used to position the barge before dumping and the knowledge of currents allows calculation of the trajectory of the dump. Dumping will be at specified points indicated by x-y coordinate control, and will employ buoy markers as necessary to assure controlled point dump positioning. Thus, the landing point of the material is reasonably predictable.

Several methods are available to improve the certainty of the fate of the material. First, underwater berms can be placed on the bed to provide disposal area boundaries. Thus material which breaks up and is in a fluidized state can be contained by this method. There is some limit to the height of such underwater berms depending on the strength of the underlying soil and the method used to build the berms (Hart-Crowser, 1985). Second, a downpipe could be constructed and suspended from a barge (Figure 3-5). Materials can be rehandled to this barge and downpipe by means of a second clamshell dredging unit. The downpipe can be extended to any depth including positioning within ten feet of the bottom. This method has several advantages. The material is not mixed into the water column on the way to the bottom. The delivery site of the material can be more precisely determined than with an open water dump. Finally, materials can be delivered to the bottom at a measured rate to assist in capping or selective filling operations.

Based on physical model results, a disadvantage of the downpipe is that the sediments will tend to entrain more water because of contact with the pipe wall and breaking apart of clumps (Engineering Hydraulics, 1986). This results in a suspended sediment with less soil strength which can reduce the ability of contaminated sediments to support cap material placement. As a result, the capping operation could be delayed to allow some settlement and consolidation of contaminated sediments prior to cap placement.

Hydraulic pipeline dredges are conventionally used to deliver material to intertidal or upland disposal areas. In the conventional situation, material is pumped in a slurry form in pipelines ranging from 20 inches to 30 inches in diameter for project conditions at the site. On water, the pipelines are supported by pontoons as floating lines and can be submerged if necessary for

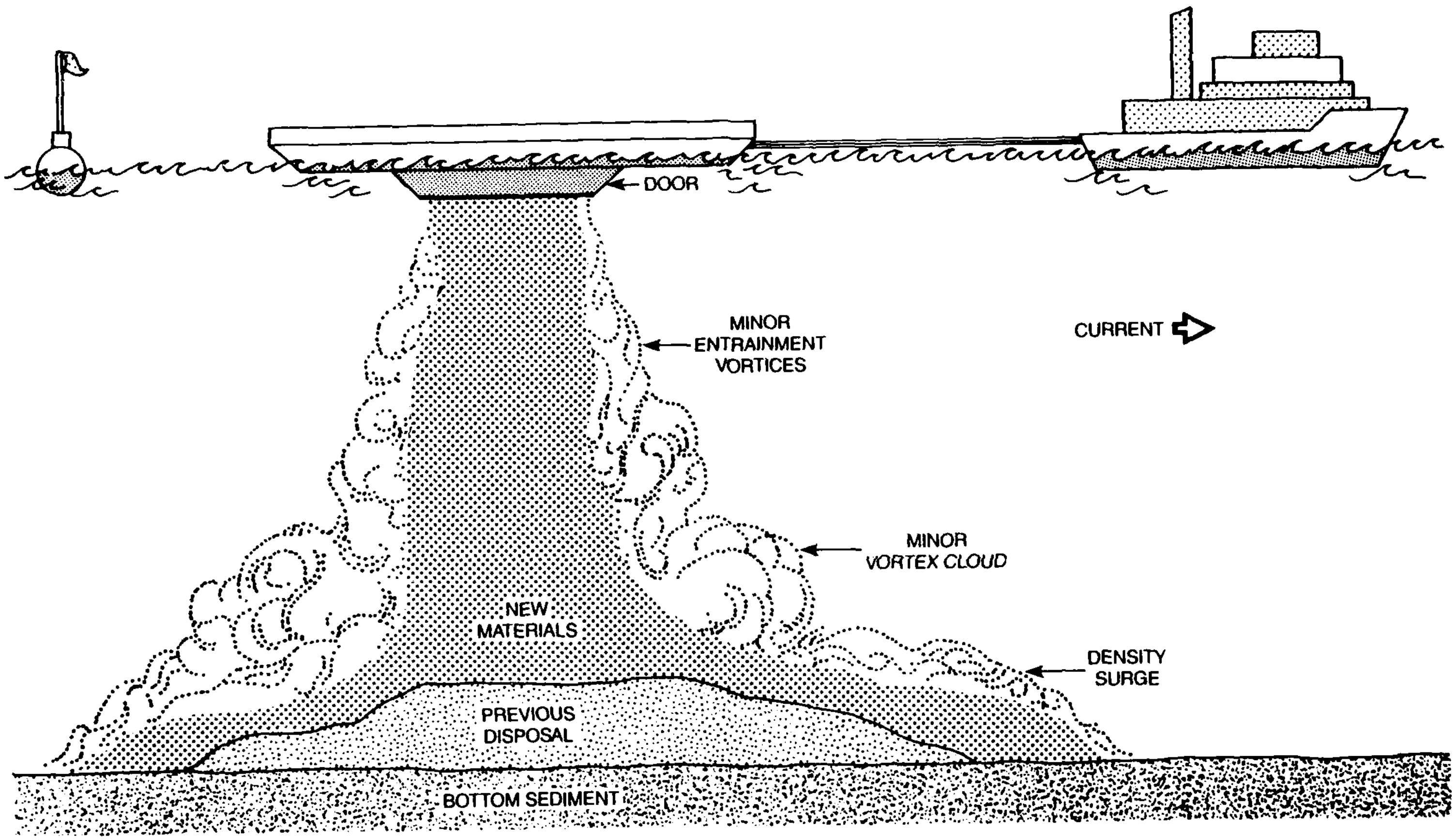

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Figure 3-4.
Dredged material discharged from a barge.

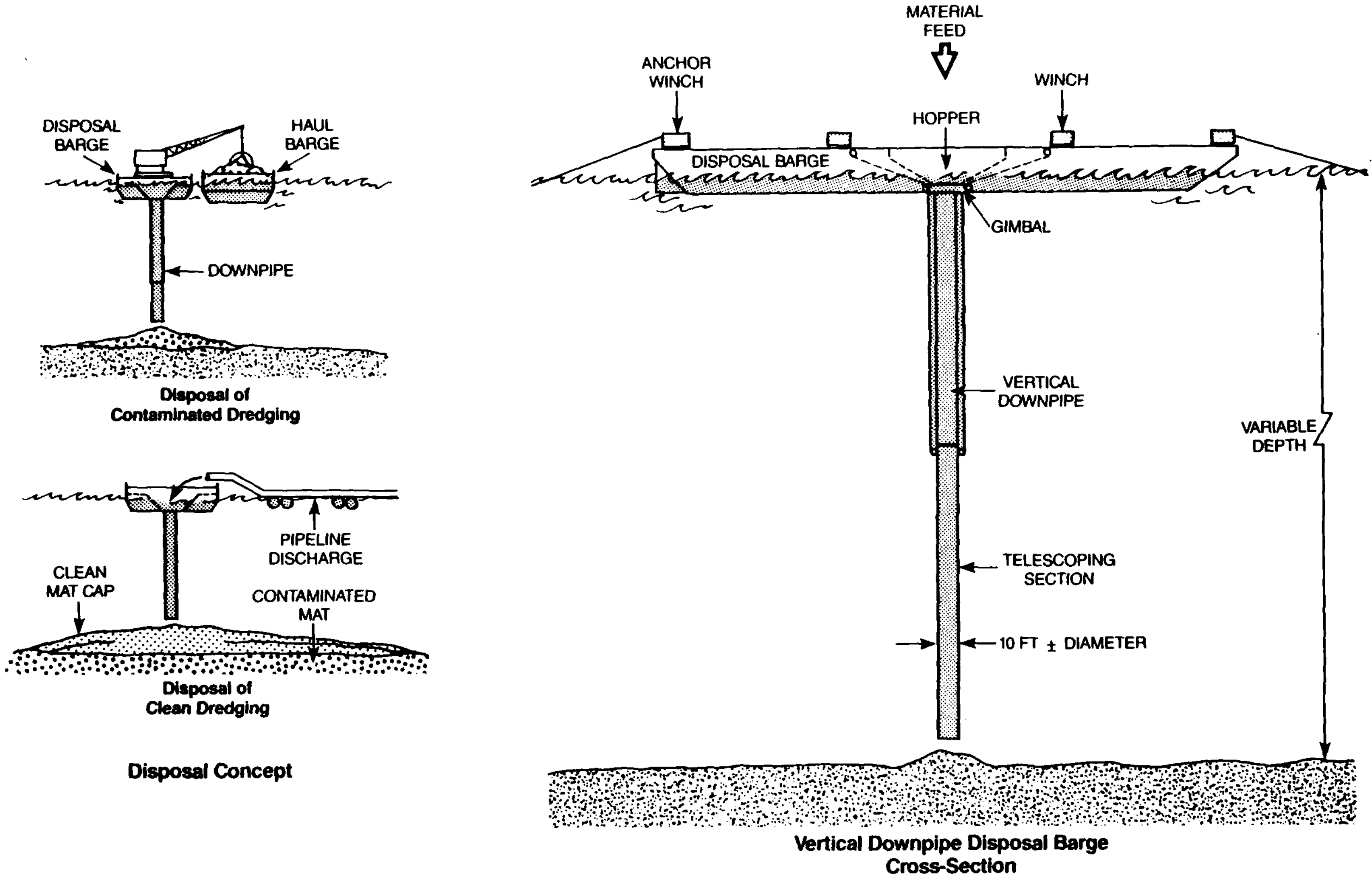


Figure 3-5.
Vertical downpipe disposal.

the convenience of navigation. On land, the pipelines require a narrow right of way between the point of landing and the disposal area. Material is pumped directly into the diked disposal area (Figure 3-6). If there is sufficient sand in the slurry, land will be built up and the pipeline discharge extended into the fill. If not, the material assumes a very flat slope between the point of discharge and the spillway return to the receiving waters.

Generally, the most important design criteria for upland disposal areas is the area size and geometry. The quality of the water effluent from a properly designed disposal area can be accurately predicted. Water quality measurements at the point of discharge and in the mixing zone are taken at intervals to assure that ponding is effective in settling out the solids in the slurry.

Hydraulic pipeline dredges can also be used to dredge and place material in open water disposal areas. The discharge can simply be set at the surface which will result in a high degree of turbidity in the water column. A large downpipe (as described above for use with mechanical dredges, Figure 3-5) could also be used. Material would simply be discharged into the pipe and allowed to settle from the bottom outlet at its natural rate of fall. Alternatively, an extension of the discharge pipeline used to deliver the material to the site could be used to place the material on the bottom. In this method, some type of diffuser would be necessary to reduce the high velocities and high pressures in the pipeline and allow the material to fall to the bottom at a minimum velocity more in keeping with its natural fall velocity (Figure 3-7).

3.4. Disposal Methods Analyses

Final design for dredging of East Waterway for the USN Homeport will depend upon selection of the disposal site and method for containment of the contaminated portion of East Waterway sediments. Identified options include capped confinement in deep waters of Port Gardner nearshore confinement in the intertidal zone confined upland disposal, and ocean disposal (see Figure 3-8). Factors influencing disposal design include sediment physical and chemical characteristics, equipment availability, and the site-specific disposal sedimentation processes. Sediment characteristics and equipment are discussed in foregoing sections. This section presents the analytical basis for evaluating disposal sedimentation processes for deep disposal by barge and vertical downpipe and for conventional controlled hydraulic disposal to a confined nearshore or upland site.

3.4.1. Deep Confined Aquatic Disposal

Deep confined/capped aquatic disposal (CAD) of contaminated sediments is not new. It has been successfully accomplished by surface barge dumping to depths up to 60-70 feet; for example, New York Bight; Stamford-New Haven, and Norwalk Harbor (O'Conner and

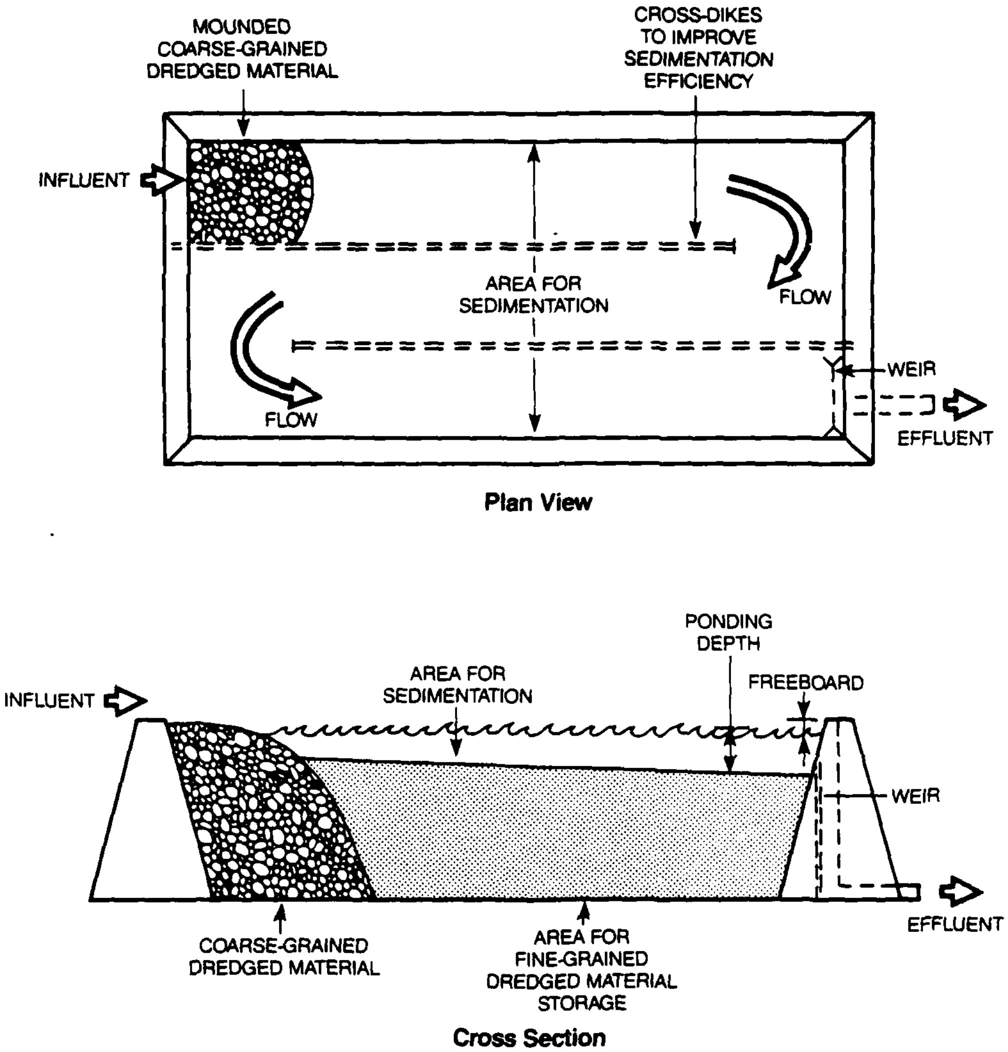
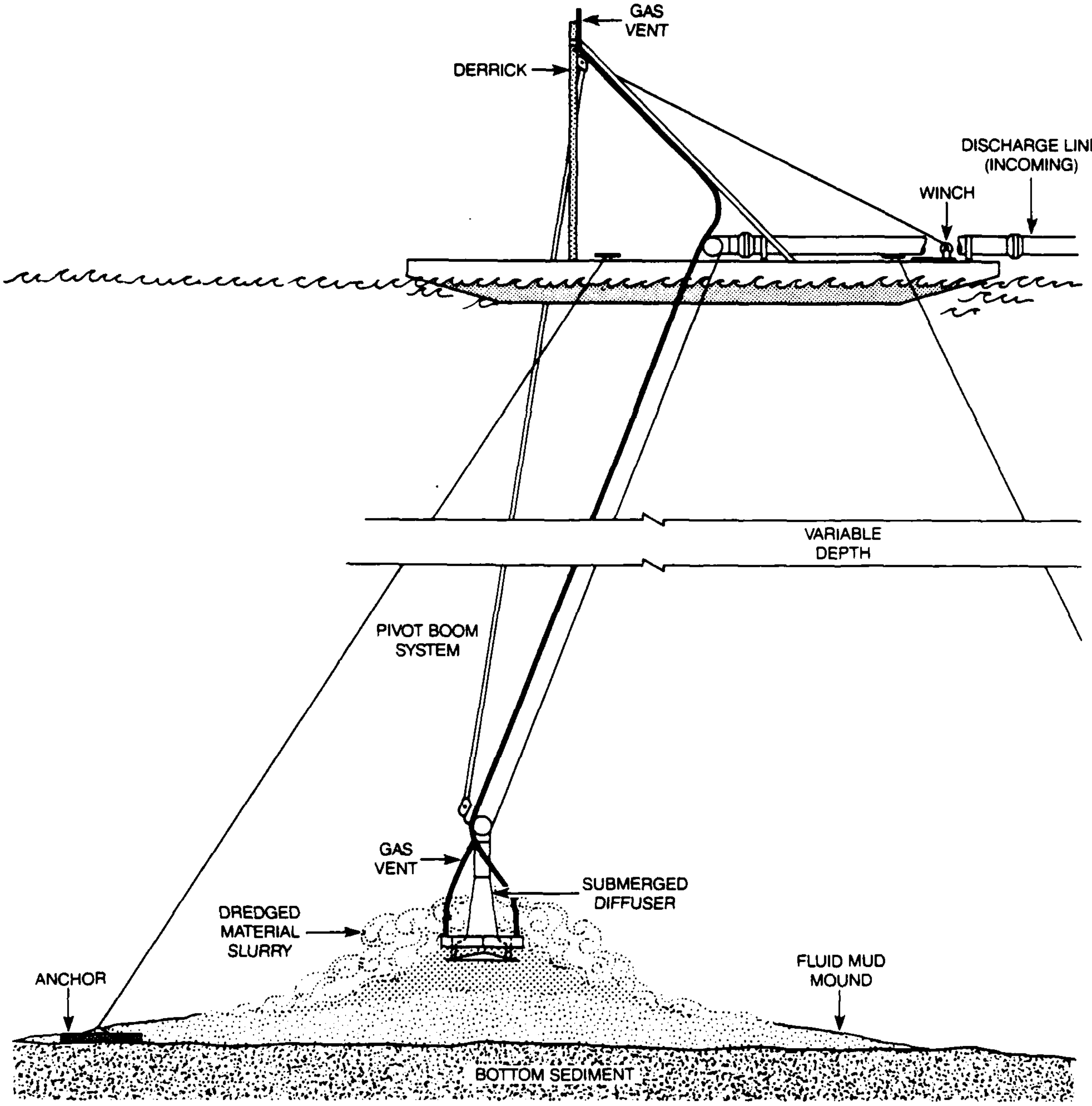


Figure 3-6.
Conceptual diagram of confined dredged material disposal site.



Source: U.S. Army Corps of Engineers
Dredged Material Research, 1978.

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Figure 3-7.
Hydraulic dredge submerged diffuser system.

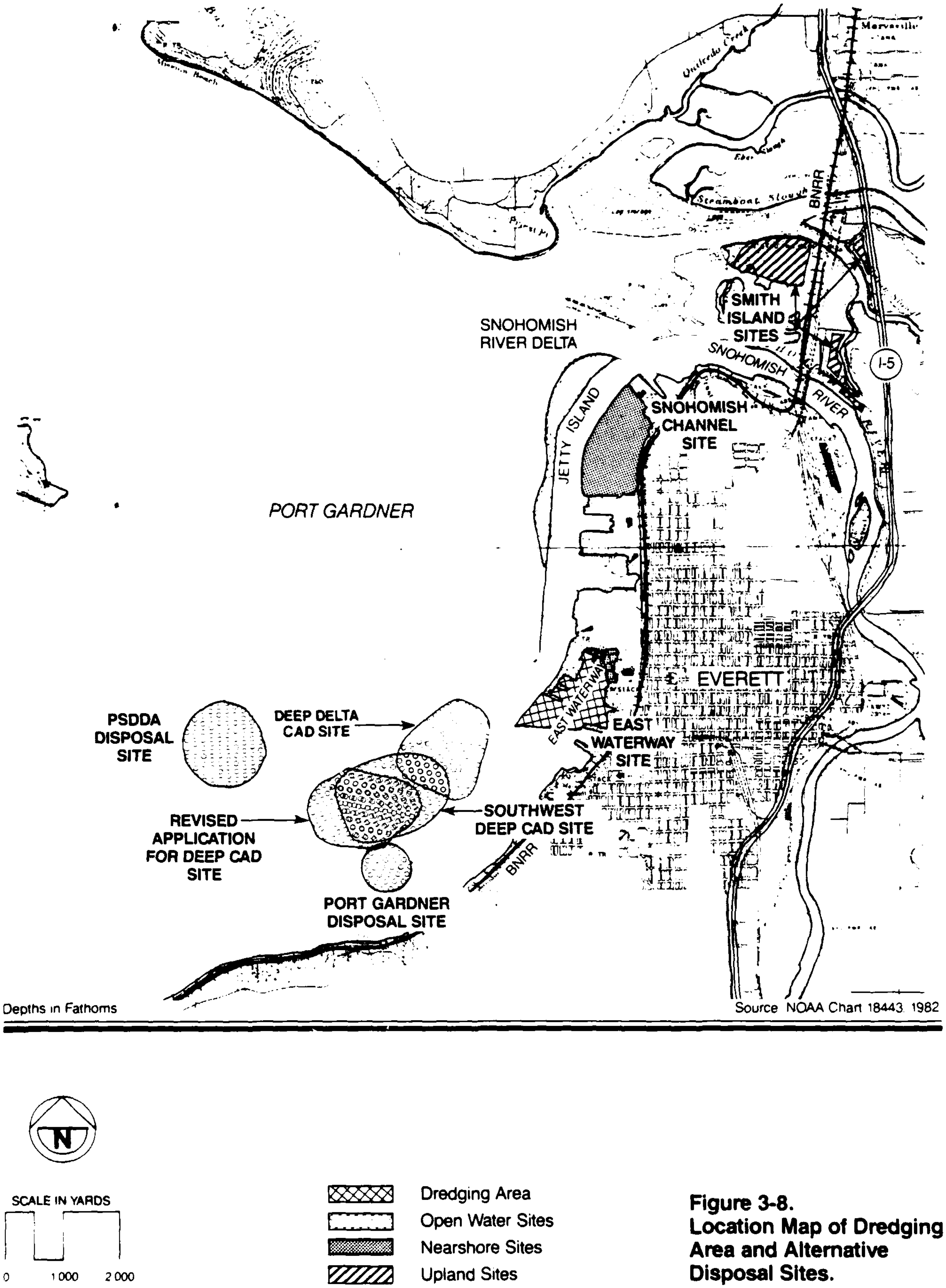

Figure 3-8.
Location Map of Dredging Area and Alternative Disposal Sites.

O'Conner, 1983); and Duwamish Waterway (Truitt, 1985, and Sumeri, 1985).

Deep water barge disposal to approximately 300-foot depth was monitored by the U.S. Army Corps of Engineers New England Division in the Atlantic Ocean off the coast of Massachusetts in 1982 (Science Applications International Corporation, 1985). Clamshell-dredged harbor sediments were released by open dump barge at a site 14.5 nautical miles from the shore marked by taut-wire buoy. Subsequent hydrographic and sediment surveys could not detect a mound of disposed materials at the buoy but evidence of dumping was apparent at distances of up to approximately 2300 feet from the site. Based on follow-up investigations, it was determined that, contrary to specified disposal procedures, dumping of materials took place while the barges were still underway. Comparison with other deep disposals, where more accurate placement did produce clearly discernible mounds, supports the importance of controlling contractor performance at the dump site to insure that operational and design requirements are met, and that monitoring of the disposal operation occurs.

To provide a basis for evaluating barge dump and down pipe disposal in deep water, the Waterways Experiment Station (WES) conducted disposal modeling to determine the behavior of contaminated dredged material during placement for the CAD alternative. Of special interest were both the degree of sediment spread on the bottom and the estimated portion of the total sediment which would remain suspended in the water column long enough to be carried from the site by ambient currents (i.e., mass loss). Modeling was conducted for disposal of one (4,000 cubic yards) barge load of material at the surface, for one barge load of material dropped incrementally through a vertical pipe (submerged discharge point), and for a confined surface hydraulic discharge. Additional physical model tests were completed by Northern Technical Services on the incremental dropping of barged sediments through a vertical pipe. Information concerning multiple loads on sloped surfaces was extrapolated using slope information from other disposal sites, soil characteristics of East Waterway material, and bathymetry information at the site.

The model used was specifically designed for instantaneous discharge from a barge or scow (Appendix D of the DEISS) and mathematically describes the convective descent, bottom collapse, and subsequent outward density surge and dispersion of the disposed sediment mass as shown in Figure 3-9. This model has been successfully applied and adapted by WES to dredged disposal situations including barge discharges, e.g., San Francisco Bay (Alcatraz Island Disposal Site, Trawle and Johnson, 1985). Methods and results of the modeling work are given in Appendices B and D of the DEISS.

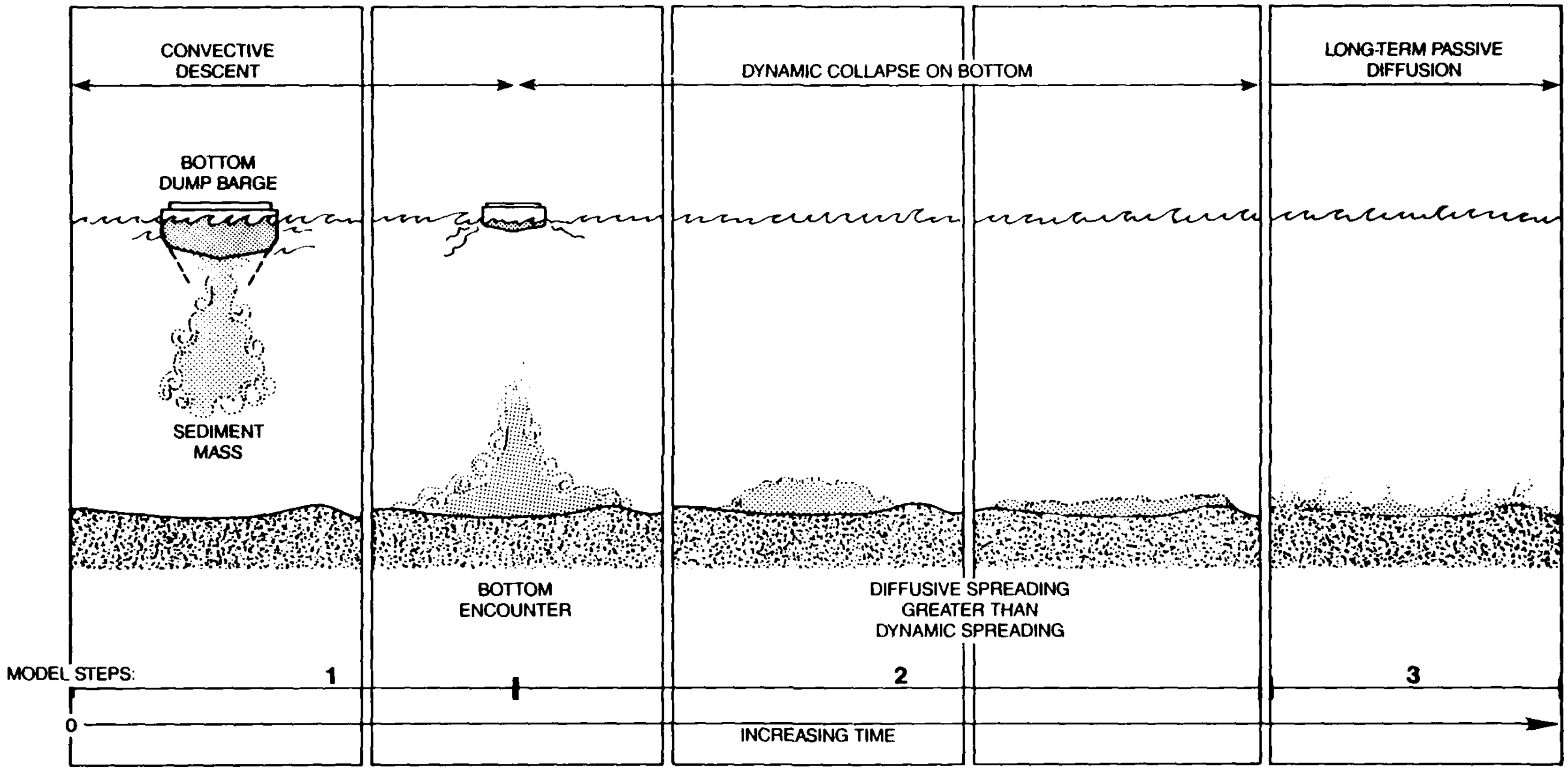

Figure 3-9.
Modeling concept for instantaneous surface release of dredged sediments in deep water.

3.4.2. Barge Disposal at the Surface

Numerical modeling of barge disposal at the surface was adapted to site-specific conditions of the Deep Delta CAD site (see Figure 3-8) for disposal taking place in 265 feet of water. A total of 4,000 cubic yards of sediment was released from the barge. Sediment properties (density, grain size distribution) were assigned based on East Waterway sediment characterization. Model coefficients for bottom friction and diffusion were based on calibration using previous Elliott Bay data with modification to reflect changes in depth and water currents. Separate model runs were conducted to evaluate the effect of cohesive "clumping" of the materials disposed, and for near-bottom velocities of 0.1 and 0.5 feet per second. Each model was run to simulate a prototype time period of 3,600 seconds (1 hour) using 300-second time steps. Results of the model runs are shown in Table 3-3. The areas with sediment deposition greater than 0.01 foot for the 4,000 cubic yard barge dump were similar for all conditions modeled.

Table 3-3. Results of Model Runs for Disposal at the Surface at Model Tim 3600 Seconds.

			--- % Remaining in Suspension ---				Deposition	
Run	Current fps	Clumping %	Sand	Silt-Clay	Wood Chips	Total	Area ft.[1]	Thickness ft.(max.)
1	0.1	0	0.7	2.0	0	1.2	800x1000	.17
2	0.1	30	0.8	2.1	0	1.3	800x800	.27
3	0.5	0	3.6	2.0	0	1.9	800x800	.16
4	0.5	30	3.1	2.1	0	1.8	600x800	.25

1 Area in feet is for deposition of material on the bottom in excess of 0.01 feet thickness. Model runs are for a single 4000 cy barge dump.

As shown in Table 3-3, the areas range from 600 feet x 800 feet to 800 feet x 1,000 feet The thickness at the center of the mound ranges from 0.16 to 0.27 feet.

The percent of sediment fractions remaining in suspension after 3600 seconds (60 minutes) is also given in Table 3-3. For all sets of current and material compositions, the total percentage of material remaining in suspension varied from 1.2 to 1.9. Recently collected current data at the Deep Delta CAD site (Northern Technical Services, 1986a) show that medial current speeds vary from 0.26 feet per second at the surface to 0.11 feet per second near bottom. Based on these data, a value of 1.5 percent after 3,600 seconds, i.e., near the middle of the range modeled, would be close approximations of model results using the measured Deep Delta site current values.

3.4.3. Vertical Pipe Submerged Disposal

Disposal of sediment through a vertical pipe with a subsurface (submerged) outlet was modeled using a series of smaller instantaneous dumps with superposition of results to yield the final deposition pattern on the bottom. The model utilized a 10-foot diameter vertical pipe extending to a depth of 250 feet (15 feet above the bottom). A total load of 4,000 cubic yards (cy) of sediment was modeled at a drop rate into the pipe of 10 cyd each minute; this rate is typical of actual production by clamshell rehandling from a haul barge into the vertical pipe. Sediment characteristics were the same as for barge dump modeling, above (East Waterway sediment). Ambient currents modeled were 0.1 and 0.5 feet per second. Modeling was adjusted to account for consolidation of the deposited mass and for the estimated impact of the emerging mound slope.

Modeling results of the vertical pipe disposal operation showed that final deposition of material on the bottom from a 4,000 cubic yard barge load is contained within a radius of approximately 50 feet from the end of the disposal pipe. The estimated thickness of the deposit was 3.5 feet. These results hold for both 0.1 and 0.5 feet per second currents. The model also indicated that all materials would be deposited on the bottom prior to transport by currents.

3.4.4. Hydraulic Discharge

Hydraulically dredging the uncontaminated material for the capping operation was model tested. Hydraulic dredging model tests are applicable to both the pipeline dredge discharge and the pumpout barge discharge. Both methods would employ discharge of a homogenous slurry of sediments from a pipe with diffuser at a specified elevation above the bed and at a specified horizontal position. Slurry density would approach 20 percent of in situ sediment density in a pipeline dredge and 40 percent of in situ density in a pumpout barge. Three capping methods were simulated - a moving surface pipe discharge, a pipe discharge into a stationary 50-foot downpipe, and a pipe discharge into a 150-foot downpipe. The downpipe radius tested was ten feet. Preliminary results of the confined surface discharge, preferred plan, are discussed. The model tests consisted of a moving pipe along a 1,400 foot long track over a 2,800 second time period. Discharge rates of 20, 30, 40, and 50 cubic yards per minute were tested. Typical results of this discharge method show that more than 90 percent of the disposed uncontaminated material will deposit within one hour. The swath of deposition will be less than 300 feet wide with maximum thickness on the order of 0.5 to .1 foot. Bottom impact velocities of the material will be less than 0.5 feet per second.

3.4.5. Confined Nearshore and Upland Disposal

The physical/hydraulic processes for disposal of hydraulic pipeline dredged materials into a confined (diked) area is essentially the same for both nearshore and upland disposal sites. As earlier described, a sediment-water slurry is discharged into the confined area where sediments are allowed to settle out prior to discharging the clarified supernatant water as disposal pond effluent. This sedimentation process is well understood and provides a proven basis for design of the disposal site, its operation, and resulting impact. A typical disposal pond is shown in Figure 3-6.

The efficiency and effectiveness of the settling process depends upon pond configuration, retention time, and the settling characteristics of the dredged sediment. Requirements for volumetric storage, minimum surface area and effluent suspended solids concentration were derived by WES for various hydraulic pipeline dredge production rates using the settling data for East Waterway contaminated sediments and procedure given in Palermo et al. (1978). Results are given in Table 3-4 for typical hydraulic pipeline dredges disposing of 800,000 cy of East Waterway contaminated sediments.

Table 3-4. Confined Disposal Site Parameters for Representative Hydraulic Pipeline Dredge (Disposing 800,000 cubic yards of East Waterway Sediments)

Dredge Size (inches)	Volumetric Storage (cubic yards)	Minimum Surface Area (acres)	Weir Length (feet)
12	964,000	28	15
24	1,154,000	92	55
36	1,278,000	196	120

Volumetric requirements are dependent upon the dredging rate and compression settling characteristics of the sediment. Surface area requirements for effective settling are a function of the dredging flow rate and the sediment zone settling characteristics. The effluent suspended solids concentrations are dependent on the dredging flow rate, site retention capacity (time) and the flocculent settling characteristics of the sediment. WES evaluated these and other design parameters for a range of representative dredge sizes and related flow rates. Detailed methods and results are contained in Appendix D of the DEISS.

3.4.6. Mass Release

WES also estimated the expected range of contaminant release for both deep CAD and confined nearshore/upland disposal (Appendix B

of the DEISS). While there is no regulatory standard limiting mass release, the calculation does provide a basis to compare performance of mechanical or hydraulic dredging methods or of individual disposal sites. A summary of potential mechanisms of release and preliminary estimates of the release is outlined below:

<u>Mass Release for CAD</u>

Dredging (clamshell)	-	less than 2 percent
Transport (hopper barge)	-	negligible
Water Column (disposal at surface)	-	less than 2.1 percent
TOTAL :		less than 4.1 percent

<u>Mass Release for Confined Nearshore/Upland Disposal</u>

Dredging (hydraulic pipeline with cutterhead)	-	less than 1 percent
Transport (pipeline)	-	negligible
Site Dependent Factors:		
Effluent (PCB 1254 only)	-	3.3 to 5.5 percent
Runoff (w/suspended solids control)	-	negligible
Leachate (anaerobic)	-	negligible
TOTAL:		less than 4.3% to 6.5%

Based on elutriate analyses, PCB 1254 is the contaminant for which mass release is a significant contribution to the total. For nearshore/upland disposal, mass loss of the suspended fraction of PCB 1254 could be controlled by improved sedimentation within the settling pond prior to discharge (see Section 3.5.2.1). It should be noted that mass loss in the dredging effluent return flow is dependent upon retention time of the disposal site. Calculated mass release for PCB 1254 varied from 3.3 percent for small capacity dredge to East Waterway site, to 5.5% for a large dredge to Snohomish River Site.

Also, some escapement of the contaminated material will invariably occur during deposition at the CAD site given the depth of water at the site and the unknowns of exactly how the material will settle on the bottom or respond to cap placement. The loss is expected to be minor: the site is designed with a downslope containment berm; a cap will exist around the contaminated material; currents are very weak; and special, careful disposal operational controls, along with monitoring, are proposed.

No estimate is made of the magnitude or fate of these minor losses in terms of areal extent or thickness of eventual deposition or potential biologic impacts. However, because the bulk of contaminants is highly sediment bound to inorganic particles (sand/silt) which tend to settle out, most deposition would be in the near vicinity of the target zone.

3.5. Design Requirements

Based on the extensive tests and analyses, WES has concluded that both deep water confined aquatic disposal (CAD) and nearshore or upland confined disposal for contaminated sediments are technically achievable with site-specific design. Testing has shown that chemical contamination of East Waterway sediments is highly sediment-bound, thereby guiding selection and design of disposal alternatives to meet environmental criteria. WES has identified basic design requirements and conclusions for generic disposal alternatives for East Waterway contaminated sediments (Appendix D of the DEISS), outlined below:

3.5.1. Deep Confined Aquatic Disposal

The deep water CAD alternatives (see Figure 3-8) calls for controlled placement and capping of contaminated sediments within a limited area on relatively flat bottom at depths of approximately 240 feet to 430 feet. An option could include construction of low underwater berms for containment of the deposited sediment. This option has been selected for the preferred alternative. Although CAD operations have been successfully accomplished in depths to 100 feet, they have not yet been demonstrated in waters as deep as proposed for deep CAD in Port Gardner. WES concluded that CAD is technically feasible at such depths; however, the cost would be greater than similar operations at shallower depths. Further, deep water CAD would require provisions for precise positioning of equipment and monitoring of the operation in progress.

3.5.1.1. Subaqueous Confinement

Use of an underwater berm would provide lateral confinement to the sediment deposit. This would limit lateral spread of the sediment mound on the bottom and minimize capping material requirements. Such a structure is technically achievable and could be created by controlled surface dumping or use of a submerged discharge for more control in placement.

3.5.1.2. Submerged Discharge

Standard elutriate tests indicate that contaminants released in dissolved form are either below background or criteria levels within a short distance of the disposal operation. Therefore,

requiring a submerged discharge for placement of contaminated material is not justified from the standpoint of water quality.

Modeling results indicate that use of a submerged discharge point, i.e., vertical downpipe, will allow all materials to reach the bottom prior to transport beyond the disposal site by ambient currents.

Although not required from an environmental standpoint, use of a submerged discharge point could allow more precise placement and economy of materials. A submerged discharge point is the release of dredged sediments into the water column at some depth below the water surface. This is a desirable construction objective for placement of capping materials. A submerged hydraulic discharge with diffuser is anticipated for disposal of all hydraulically dredged capping sediments in the CAD site concept. A diffuser is required to reduce the discharge velocities at the point of release from the pipe. Typical velocity reduction will be on the order of 10% of discharge velocity in the pipeline.

Depth of discharge will vary depending on the monitoring measurements of the actual cover that occurs during disposal operations. The actual depth of discharge is a function of the elevation of the discharge above the bed and the water depth. Prototype measurements for spread versus height above the bed at the Terminal 2 Rehabilitation for the Port of Portland, Oregon (1985) suggests the spread of fine grain sand sediments discharged vary at a ratio of approximately 2 to 1 with the elevation of the pipe above the bed. The contractor will be required to vary the discharge elevation to assure adequate cover and not overdeposit on the contaminated sediments creating a mud wave displacement of the contaminated sediments. This could include a discharge near or on the surface if necessary to assure adequate cap material spread and cover.

3.5.1.3. <u>Cap Thickness</u>

An effective cap thickness of 80 cm is required; this is based on 30 cm to chemically sequester the contaminated material from the overlying water column and an additional 50 cm to protect against bioturbation. Placement of a precise and uniform cap thickness is not operationally practical. Application of a one meter (approx. 3.3 ft) or greater cap thickness will therefore be specified as an operational requirement. Disposal site design has applied a 1.4 meter (4.5 ft) cap thickness averaged over the contaminated materials area. This will allow for some irregularity in the cap thickness without violating the required effective cap thickness of 80 cm. It is noted that older geoduck clams may burrow to depth of 75 cm (Kozloff, 1973). Although presence of geoducks at deep water sites in Port Gardner is not described, their occurrence is probable. A minimum cap thickness

of one meter (3.3 feet) minimum is expected to provide adequate capping thickness to accommodate such bioturbation.

Actual cap thickness upon project completion depends on the construction variables of placement method, sediment consolidation, and relative volume of capping materials to area of contaminated sediment to be capped. To provide a safety factor for design and construction uncertainties within the ratios of available contaminated/clean materials, a cap thickness of 1.4 meters (4.5 feet) is selected as a conservative design target to insure the recommended minimum 80 cm cap throughout the project. Monitoring of actual cap thickness and integrity during and after construction will be conducted to guide placement and final CAD dimensions (see Dredge and Disposal Monitoring, Section 12.2.2.4.1).

3.5.2. Confined Nearshore or Upland Disposal

Basic design requirements for storage of dredged materials and solids retention during the disposal process are similar for sites constructed nearshore and in upland areas (see Figure 3-8 for nearshore/upland site locations). Requirements for volumetric storage, minimum ponded surface area, effluent suspended solids, and weir length requirements can be determined for site-specific dredging and disposal conditions using the settling data determined by WES (Appendix D of the DEISS) and procedures given in Palermo, et al. (1978). Examples for a 24 inch hydraulic pipeline dredge were given in Table 3-4.

3.5.2.1. Effluent Controls

Based on the modified elutriate test results, no controls for removal of dissolved contaminants are required to meet water quality criteria if mixing to a dilution factor of approximately 13 can be achieved within a mixing zone of acceptable size. Mass release of contaminants during filling operations, including both dissolved and particle-associated, were calculated to be less than 1 percent for all parameters except PCB 1254 with a loss of 3.4 percent.

Mass loss occurs with both dissolved and suspended contaminants. The suspended portion of mass loss could be controlled by adequate sedimentation of particles within the settling pond. This can be accomplished by using chemical clarification or by increasing the effective retention time prior to overflow. Means of increasing retention time include using a smaller dredge, periodically curtailing dredge operations to reduce inflow rate, and/or improving hydraulic efficiency of the pond by constructing cross dikes to minimize short circuiting flows.

3.5.2.2. Surface Runoff Controls

Sedimentation or erosion control of surface runoff is required to remove the particle associated (suspended solids) fraction of contaminants. See Section 3.5.2.3, below. Based on the results of surface runoff testing, no controls are required for removal of dissolved contaminants if mixing to a dilution factor of approximately 18 can be achieved within a mixing zone of acceptable size. Calculations showed that mass release of contaminants from a representative 100 acre disposal site and representative storm events was negligible when compared with the total mass of sediment placed in the confined site.

3.5.2.3. Surface Cap

Placement of a cap of clean material is required as a measure of surface runoff quality for the confined disposal alternatives. A surface cap of clean material would retard oxidation of the surface layer, protect against potential erosion and prevent contaminant uptake by plants or animals which might colonize the site or any future use of the site. A surface cap of 6 feet has been identified as adequate relative to future revegetation or use. (Phillips, et. al., 1985).

3.5.2.4. Leachate Controls

Potential problems with metals release in both the anaerobic and aerobic leachate will require analysis prior to final site design. Aerobic leachate tests indicated the fraction of metals that was resistant to anaerobic leaching was generally greater than 90 percent of the bulk sediment concentration. Under aerobic conditions, over 85, 57 and 49 percent of the Zn, Ni and Cd was mobilized in the tests. These same metals experienced 4, 8 and 7 percent mobilization. Test results predict that leachate qualities of Cr and Pb for the anaerobic conditions slightly exceed drinking water standards. In aerobic disposal environments, Cd, Cr and Pb would exceed standards by a substantive amount (Appendix B of the FEISS). This indicates the potential need for restrictions to be placed on leachate/seepage generation from Everett Harbor sediment. Site specific factors will determine the type of leachate control strategy that can be successfully implemented. Potential leachate control strategies include site selection, site controls (both chemical and physical), and dredged material modification (fixation of contaminants, liming the sediment, etc.). Because of the site-specific nature of leachate controls, specific leachate control technologies, if needed, will be recommended and designed after a site is identified.

3.6. Dredge/Disposal Site Alternatives

During the process of developing the Navy FEIS, an attempt was made to identify as many different dredge disposal sites and related disposal methods as possible. Table 3-5 summarizes the

alternative disposal sites considered in the analysis. (See Figure 3-8).

Table 3-5. Alternative Dredge Disposal Sites Considered in the Navy FEIS.

Disposal Method	Location
Open Water - No Capping	Port Gardner Disposal Site Deep Delta Site Proposed Everett Jetty State Park
Confined Aquatic Disposal in Deep Water	Port Gardner Disposal Site Port Gardner Deep Water Slope Deep Delta Site
Confined Nearshore	Weyerhaeuser Site Snohomish Channel Site South Jetty
Confined Upland	Tulalip Landfill Smith Island Weyerhaeuser Site
Ocean Disposal	Site unidentified

As part of the evaluation methodology for contaminated materials, seven criteria were used to assess each of the different sites. Criteria included contaminant availability (potential for physical contact with benthic organisms), potential contaminant mobility, site environmental conditions, erosion potential, institutional constraints, site capacity, and relative cost. For clean dredge material, five criteria including site environmental considerations, availability for capping, institutional constraints, site capacity, and relative cost were applied.

Uncapped disposal of contaminated materials in open water was determined to be unacceptable because of contaminant availability and the potential for contaminant mobility (U.S. Army Corps of Engineers, 1985a). An upland site, the Tulalip Landfill, was considered unsuitable for uncapped disposal of contaminants for the same reasons. In the first round "paper" analysis, the Weyerhaeuser, Snohomish Channel, proposed Jetty State Park, and South Jetty sites received relatively low ratings. For disposal

of both contaminated and clean materials, the Port Gardner Disposal Site, the Deep Delta site, and the Port Gardner Deep Water Slope site were all considered viable.

Since completion of the Navy FEIS, a considerable amount of additional research has been conducted to characterize the dredge disposal material and evaluate the practicality and environmental impacts of different disposal programs. The additional information warranted the review and further consideration of alternatives beyond the original FEIS level of evaluation.

These alternatives include open water, nearshore, upland and ocean sites; however, no site has been identified for ocean disposal. A definition of these sites has been developed based on the results of the sediment tests and the fact that the contaminated portion of the sediments remain sediment bound while the sediments are in the anaerobic or saturated, wetted state (Appendix D of the DEISS). Surface runoff over sediments that have previously dried will cause significant degradation of water quality due to high resuspended solids and a dilution factor greater than 18 is required to reduce dissolved suspended sediment concentration to criteria levels in seawater. Leachate testing shows that the contaminated sediments subject to aerobic conditions may require long-term treatment and possible disposal site liner construction to prevent groundwater contamination. Table 3-6 presents the alternative dredging and disposal site methods considered in this document.

The following definitions of sediment disposal include descriptions of their long term condition:

Open Water Unconfined:	Disposal of uncontaminated sediments in the open water. Sediments will remain saturated.
Open Water Capped:	Disposal of contaminated sediments in the open water, then placement of uncontaminated sediments over as a cap. Contaminated sediments remain saturated.
Nearshore:	Disposal of contaminated sediments to a site that has a groundwater or tidal condition that keeps the sediments in a saturated anaerobic condition.
Upland:	Disposal of sediments to a site that is above the groundwater or tidal influence. The sediments eventually dry, and become aerobic.

Table 3-6 Alternative Dredge and Disposal Sites Considered in the EISS.

Dredging Method	Disposal Method	Disposal Site
Clamshell & Bottom Dump	Open Water	Port Gardner
Clamshell & Bottom Dump of Contaminated sediments Pipeline dredge uncontaminated sediments	Open Water Capped	Deep Delta CAD Southwest Deep CAD RAD CAD
Clamshell & rehandle all sediments to downpipe with berm construction	Open Water Capped	Deep Delta CAD
Pipeline all sediments to diked site, sediments remain saturated	Nearshore	Snohomish River
Pipeline contaminated to saturated diked site, uncontaminated to CAD	Nearshore/ Open Water	East Waterway/ CAD
Pipeline contaminated to saturated diked site, uncontaminated to CAD	Nearshore/ Open Water	Smith Island/ CAD
Pipeline all sediments to diked site	Upland	Smith Island
Clamshell & Bottom Dump haul to Ocean	Ocean	Contiguous Zone

3.6.1. Offshore Disposal

A detailed locational analysis was undertaken within Port Gardner to identify potential site alternatives for disposal of dredge material by the confined aquatic disposal (CAD) method. As initial steps in the site identification process, a bathymetric survey was conducted of much of Port Gardner, focusing on areas shallower than 400 feet. Subsequently, core samples were taken throughout the area and a map of sediment types was prepared. Areas of potential geotechnical risk, as indicated by recent slumping and other factors, were identified as well. Other significant characteristics, such as the location of outfalls, were also mapped.

The key siting criteria, based on engineering and construction reliability, used to select potential sites included the following:

- Potential for subsequent natural deposition - The site should be in a zone of accretion. That is, natural deposition of sediments that would add to the thickness of the capping material was considered to be beneficial. Conversely, areas of potential erosion that could remove cap material were to be avoided.

- Geotechnical stability - The site should be in an area with no evidence of slope movement. Areas where slumping was identified or where there was a high potential for slumping (in particular, steep slopes) were to be avoided.

- Site configuration - The site should be relatively flat so that the deposited dredge materials would stay in place. An upwardly sloping terrain on one side of the site was considered beneficial, because the slope would function as a natural berm. The natural berm would help confine the cap material and allow a thicker cap to be constructed.

- Site size - The final size of the CAD site is not significantly affected by the materials deposited from any single barge disposal or by the material discharged during small increments of time by a controlled hydraulic pipeline dredge. The disposal model data indicates that the major portion of each 4000 cubic yards barge disposal will be deposited in an area approximately 1000 feet in diameter or about 20 acres. The spread of capping sediments from a pipeline dredge discharge is controlled by elevation of the discharge above the bed. The overall size of the disposal sites is governed primarily by the total amount of material being deposited, sediment bulking factors, stable side slope characteristics of the sediments, existing bottom topography and consolidation characteristics of both the bed and the dredged material. The initial area of deposition for both the barge and hydraulic dredge methods can be expected to increase with increasing depth. For the depth range identified in the general CAD disposal vicinity, the increased depths will not cause an increase in the initial areas of deposition enough to become significant in increasing overall site size.

- Other factors - Facilities already in place, such as outfalls, were to be avoided so that there would be no

interference with their operation. Dredge disposal sites that have experienced permitting difficulties were considered less desirable. Other potential disposal sites were also avoided because other future disposal activities could potentially violate the integrity of the CAD cap.

Much of the study area was considered unsuitable for a CAD site because of steep slopes or evidence of unstable geotechnical conditions. The Port Gardner disposal site was ruled out because open water disposal criteria for the site prevents disposal of contaminated sediments, thereby limiting the site to clean material disposal only. The preferred site presently being considered by PSDDA for disposal of uncontaminated dredge materials was considered undesirable due to the potential for future disposal operations disturbing the CAD cap.

A second area immediately southwest of the Deep Delta CAD site and labeled the Southwest Deep CAD site was examined in greater detail. The latter site is situated at a depth of approximately 350 feet. This disposal site would require an estimated 315 acres compared to about 280 acres for the Deep Delta CAD site because of differences in bathymetry.

Increased disposal site size implies that a given volume of clean cover material will result in a proportionally reduced cap thickness. Consequently a supplemental source of clean cover material may be required for larger site area options to meet the design target of 1.4 meter cap average thickness.

Following review of the Draft EISS, a third potential CAD site in Port Gardner was considered. This site was labeled RAD CAD, and was examined in greater detail. See Figures 3-8, 3-10 and 3-11b for locations and configurations of the CAD alternatives.

The major consideration for design of any CAD site (see Figure 3-8) is the containment of contaminated sediments from the dredging operation. The primary mechanism for containment is the placement of a cap of uncontaminated sediments over the contaminated sediments after their deposition. The cap will have a minimum thickness of 80 cm after settlement takes place (see Section 3.5.1.3.). To help ensure adequate capping under varying construction conditions, a 1.4 meter (4.5 feet) average cap thickness was incorporated as a conservative design target for this evaluation.

Assuring required cap thickness depends upon availability of an adequate volume of clean cover material to produce the necessary design cap thickness over the contaminated sediment cell area; increasing the cell area to be capped proportionally increases the volume of cover material required to maintain cap thickness.

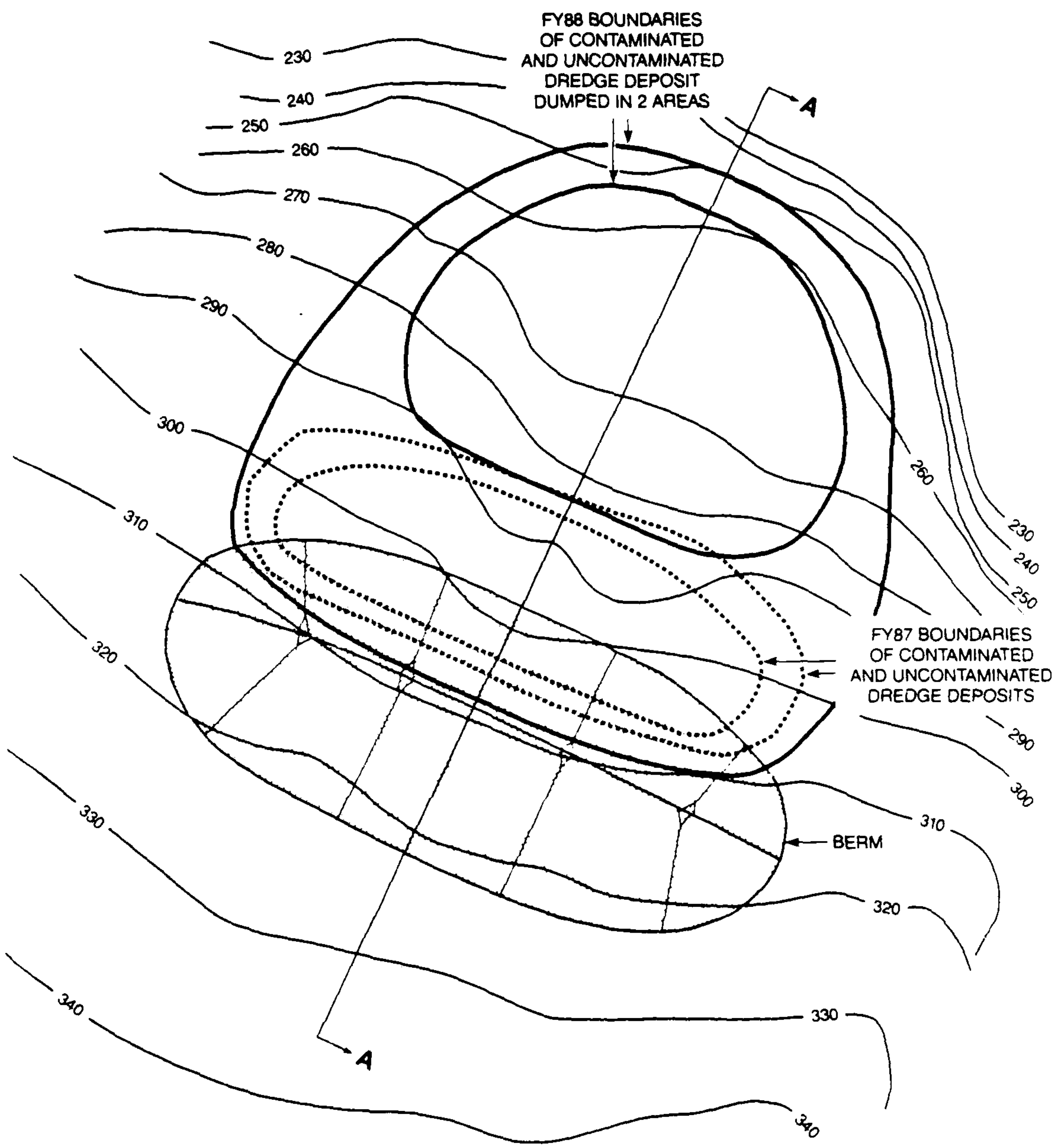

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Figure 3-10.
***Deep Delta Disposal Site* bathymetry — contour map (alternative 1: FY87-FY88 dredge deposit).**

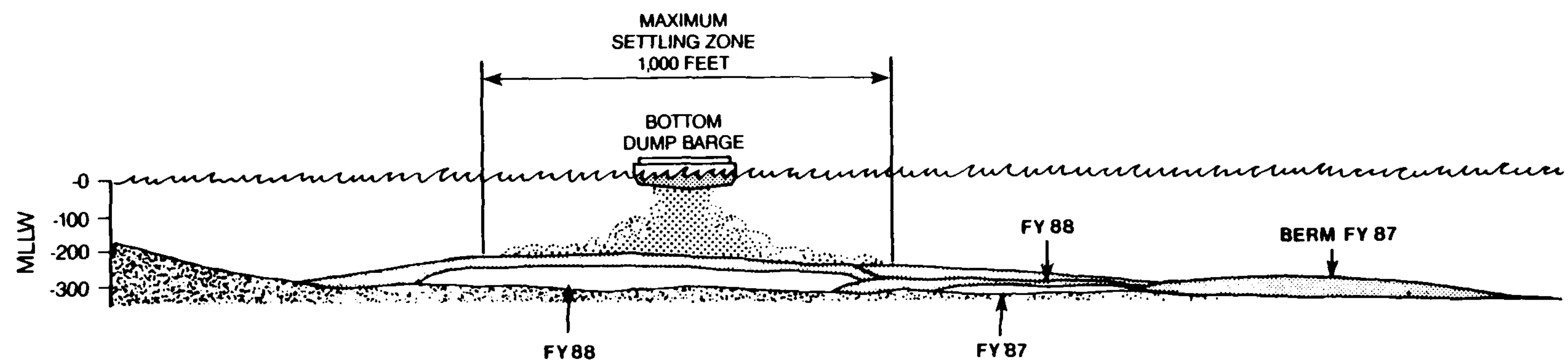


Figure 3-11a.
Section A-A through Deep Delta CAD Site (50:1 slopes).

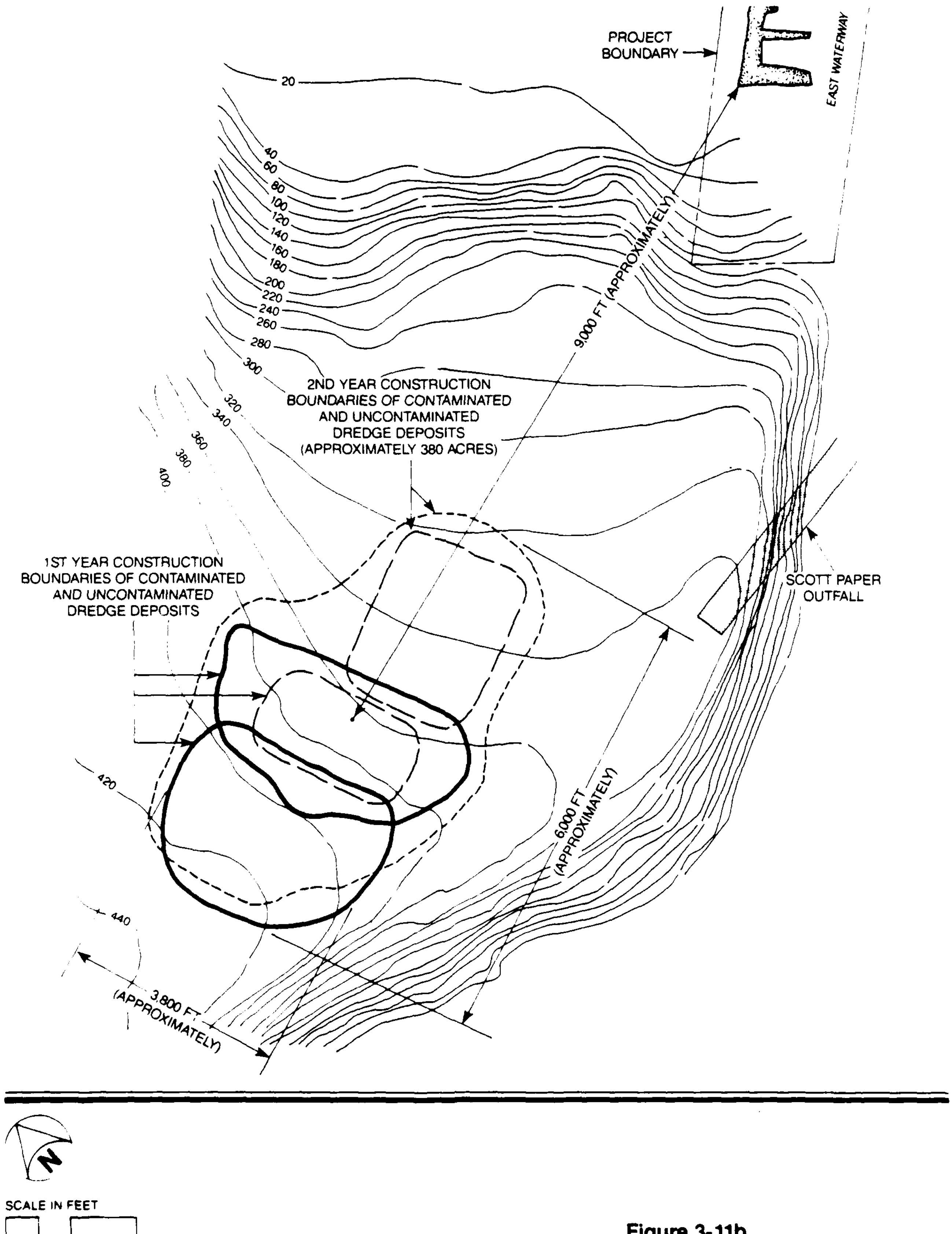


Figure 3-11b. Revised Application for Deep Confined Aquatic Disposal.

Overall CAD design then depends upon balancing available cover materials and contaminated cell size to achieve a minimum required cap thickness.

Sediment studies (Northern Technical Services and Battelle Northwest Laboratories, 1986) show that the deep CAD areas are in a long-term accretion zone with accumulation rates in the order of 0.25 cm/yr. While this rate is not significant in providing near-term additional capping thickness, it does show that erosion by water currents is not a factor in site design and cap materials will remain stable.

The use of special discharge equipment to control the placement of the contaminated and uncontaminated dredge sediments was considered at the CAD sites. For this EISS, an analysis for using special discharge equipment was provided, as well as an analysis for a standard bottom dump and hydraulic dredge operation. A discharge point that may be at or near the surface or submerged at depth will be considered for disposal of all hydraulically dredged capping sediments in the CAD site concept. Depth of discharge will vary depending on the monitoring measurements of the actual cover that occurs during disposal operations. The actual depth of discharge is a function of the elevation of the discharge above the bed and the water depth. Prototype measurements for spread versus height above the bed at the Terminal 2 Rehabilitation for the Port of Portland, Oregon suggests the spread of fine grain sand sediments discharged vary at a ratio of approximately 2 to 1 with the elevation of the pipe above the bed. The contractor will be required to vary his discharge elevation to assure the actual cover and not over deposit on the contaminated sediments and create a mud wave displacement of the contaminated sediments. This could include a discharge near or on the surface if necessary to assure adequate cap material spread and cover. Consistent with assuring adequate cover, submerged discharge can be used to limit potential local turbidity at the surface.

Hydraulic dredge discharge includes pipeline discharge of a slurry of sediment from a specified elevation above the bed and a specified horizontal position. Hydraulic pipeline cutterhead dredges with discharge pipe diameters typical of 2' to 3' are included under this category. Hydraulic pump out barges are also included. A pump out barge is a haul barge with a pumping system that allows transfer of material out of the barge as a slurry. Pump out barge pipe discharge diameters are typically 6" to 16" diameter.

Disposal of clean sediments only to deep sites in Port Gardner is being considered for use in conjunction with disposal of contaminated materials to Snohomish Channel, East Waterway, and Smith Island sites. These deep sites could include the Deep Delta, Southwest Deep and RAD CAD sites and the existing Port

Gardner site. Although not incorporated directly into this FEISS, the PSDDA process has proposed a deep water disposal site in southwest Port Gardner suitable for unconfined disposal of certain categories of sediments (U.S. Army, 1986d). This site is also being considered by the Navy for disposal of clean sediments from East Waterway to the extent that it is available prior to Navy dredging. (PSDDA is the acronym for the Puget Sound Dredging and Disposal Analysis now ongoing for future dredging and disposal operations in Puget Sound.)

The RAD CAD site is given primary consideration at this time for clean materials disposal based on the comprehensive data base. The open water sites in Port Gardner are presently not designated disposal sites by any permitting agency. Permits and authorization will be obtained through the U.S. Army Corps of Engineers permitting procedures and Washington Department of Natural Resources disposal site authorization process.

3.6.1.1 Deep Delta Confined Aquatic Disposal Site

Bathymetry and Physical Characteristics

The proposed Deep Delta Confined Aquatic Disposal (CAD) site is a relatively flat area located at the base of the Snohomish River Delta in approximately 240 to 320 feet of water. The results of a bathymetric survey of the CAD site (Northern Technical Services, 1986a) are shown in Figure 3-10. The Snohomish delta seafloor slopes downward to the disposal site at a 1 on 5 to 1 on 6 ratio. The disposal site itself has a 1 on 50 typical slope. The Deep Delta CAD site profile is provided in Figure 3-11.

Location of the Deep Delta CAD site shown on Figure 3-10 is based on review of currently available data and preliminary design. As shown the site is in slightly deeper water than initially proposed in the Navy FEIS and the Section 10/404 permit application. The relocation of the site in deeper water was intended to reduce impacts on Dungeness crab observed to seasonally inhabit the shallower zones while maintaining effective natural upslope confinement provided by the Delta base.

The results of a geophysical survey (Northern Technical Services, 1986a) indicate a near surface seabed reflector layer 40 feet or less below the mud line; this layer is referred to as deltaic sandy silt. This is underlain by undifferentiated glacial and non-glacial deposits.

Generally, most of the site is covered by a surface layer of very soft, wet, dark gray to black silt to clayey silt with numerous to scattered organics (Hart-Crowser, 1986a). The surface layer is 2.0 to 2.5 feet thick and has typical water content of 58 to 126 percent (water content equals weight of water divided by weight of dry solids).

The foundation soils for the dredge disposal consists of fine-grained marine sediments (deltaic silt) with low shear strength. The surficial deltaic silt is typically classified as CL-ML, with the natural water content above the liquid limit.

Seismic Conditions

The Pacific Northwest is a seismically active area, with the Puget Sound area classified as Zone 3 by NAVFAC P-355 and the Uniform Building Code. Earthquake considerations in seismically active areas include: the potential for and intensity of ground shaking; ground rupture due to faulting; and liquefaction. Ground shaking from a major earthquake could impact the site during the service life of the facility. Peak ground accelerations of 0.15 g have an approximate 80 percent probability of nonexceedence during a 50-year period. Such accelerations would likely develop from earthquakes of magnitude 6.5 or greater.

Ground rupture due to faulting is not a concern for the site. In the Puget Sound region all of the large earthquakes have been deep subcrustal events at depths ranging from 20 to 40 miles below the ground surface.

The deltaic silts located at the Deep Delta CAD site and upslope have low shear strength. The potential for liquefaction of the upslope deltaic silts during seismic events does exist but is not evaluated in terms of probability or severity. The geophysical data of bathymetry and seismic reflection show no indications of major seafloor faulting, slumping, or submarine slope failure (Northern Technical Services, 1986a).

In the event of a major earthquake, the site could experience localized liquefaction. This could result in localized loss of foundation support, settlement, or slope distortion. It is possible that some of the contaminated sediment could be exposed by such an event.

The natural growth of the river delta can be the product of slope failures due to liquefaction, as well as the steady accretion of river silts. If a major slope failure were to occur upslope from the Deep Delta CAD site, the resulting slump could disturb the confined disposal area and most probably would cover the disposal area with additional deltaic silt. Placement of berm would reduce potential impacts of slumping that might occur as a result of a major slope failure.

Currents

Current velocities at the Deep Delta CAD site are very low compared to other current speeds in the main tidal channels of

Puget Sound (Northern Technical Services, 1986b). Near-bottom currents are less than 9 cm/sec over 90 percent of the time and average 1-3 cm/sec. The very low instantaneous current speed results in low to no probability for erosion, entrainment and transport of dredged material by shear velocity from the near bottom currents. This is to be expected as the existing bottom sediments at the site have the same grain size characteristics.

The current regime is vertically stratified in the water column above the bed. The highest current speeds occur near the surface and their directions are evenly distributed, and show little or no tidal current orientation. The surface currents are less than 15 cm/sec over 90 percent of the time, and average 7-8 cm/sec.

In the mid to lower water column depths there is a net current flowing toward the Northwest with a speed less than 7 cm/sec over 90 percent of the time, and typically are 1.5 to 4 cm/sec.

Construction Schedule

The dredging portion of the construction has been separated into three major projects for federal funding. The project limits are identified in Figure 2-4, and include P-111 (Outer Harbor Dredging, Breakwater and Mole), P-905 (Outer Harbor Dredging, Second Increment) and P-112 (Dredging Inner Harbor). The construction schedule is connected to the funding of the three separate projects. In addition to the funding, other factors control the critical path of the dredging effort. Please see Table 2-3 for construction timing.

The initial use of the carrier pier is scheduled for December 1988. This requires dredging for the breakwater and south mole under P-111 and for the carrier access with berthing areas under P-905 to be completed prior to that date.

Construction of the central marginal wharf, a part of the upland portion of the homeport development, requires the early dredging of the shoreline in P-112. Present construction schedule for the marginal wharf indicates the shoreline dredging for P-112 must be completed early in 1988.

Another control in the dredging schedule is the fisheries protection window identified by state and federal resource agencies. Standard State of Washington requirements for dredging prohibit activities in the waterway during from March 15 to June 15. In addition, disposal activities will be avoided from late November to March 15. Egg bearing female crabs are present in the Deep Delta CAD site during that time of year.

Debris Removal

Debris removal and dredging would be performed concurrently. Surface debris and some of the immediate subsurface debris in the contaminated layer of sediments will be removed by barge mounted clamshell. This debris will be deposited on a barge, transported to a transfer site where it will be removed from the barge by a land-based crane and transported to an approved upland site.

Floatable debris or debris which by virtue of its size prevents the closure of the clamshell bucket shall be disposed upland.

Unsortable debris will be removed and disposed with the dredged sediments during clamshell dredging of the contaminated layer. Tests completed by WES (Appendix D of the DEISS) demonstrate that the project site wood-waste debris will sink. The remaining debris removed during dredging is likely to be rotted wood particles in a deteriorated condition and wire, concrete or cable.

Sediment Removal

The proposed dredge operation will utilize techniques that are common practice in the industry for removing debris and sediments. Contaminated sediments will be removed by a barge-mounted clamshell. Uncontaminated sediments will be removed by hydraulic pipeline dredge equipment or by clamshell with hydraulic pump out barge.

Selection of clamshell dredge equipment to excavate the contaminated sediments and hydraulic dredge equipment to dredge the uncontaminated is based on the relative sediment strength and water content of the sediments when they arrive at the disposal site.

The contaminated sediments in the East Waterway are the surface sediments deposited most recently. These sediments are fine grained and have a high water content typically at 157 percent. The uncontaminated sediments below the surface are also fine grained, but are more compact with lower water content. The uncontaminated or capping sediments have a water content typically near 50 percent (Hart-Crowser, 1985).

Given these conditions, the ability of the contaminated sediments to support a cap material is relatively low and was considered in determining the dredging and disposal methods discussed below. The clamshell dredging operation allows removal of the contaminated sediments without introducing significant additional water, thereby retaining most of the in situ sediment strength. The sediments will also tend to consolidate in the barge prior to dumping which will assist in maintaining their predredged, in situ structural strength. Excavation of uncontaminated, clean sediments for capping would then be accomplished by clamshell to a pump out barge for disposal or by hydraulic dredge with

discharge at the disposal site. The pump out barge will introduce water into the uncontaminated sediments typically creating a 40 percent in situ solids volume to water volume slurry. The hydraulic pipeline dredge will introduce water into the uncontaminated sediments, typically creating a 20 percent in situ solids volume to water volume slurry ratio. The resulting water content of the uncontaminated sediments at the disposal site will approach and exceed that of the contaminated sediments.

The cap material can be discharged from a point elevated above the bed, allowing the sediments to reach the bed at a fall velocity relative to their grain size. In effect, the cap material will rain down upon the contaminated sediments to gradually cover them. The use of this method would allow the contaminated material to support the cap material. Progressive monitoring of the bed (see Section 12.2.2.4.1) and movement of the discharge location will be accomplished to assure gradual building up of the overburden cap, thereby avoiding contaminant displacement. This same approach has been used with success at Terminal 2 reconstruction in the Willamette River in Portland, Oregon (Port of Portland, 1985), and at port construction projects in Long Beach-Los Angeles, California, and China.

An alternative to barge dumping of contaminated sediments includes pipeline dredge discharge using a diffuser system (Neal et al., 1978) (see Figure 3-7). The principle of the system is to reduce the discharge velocity so that the slurry is discharged without dilution and, therefore, will tend to settle out quickly and mound in the immediate vicinity of the discharge point. The result is a more diluted sediment than the barge dump, but a placement in a smaller, more specific location than the barge dump operation.

<u>Disposal Option</u>

Two alternatives for disposal have been analyzed. An initial alternative selected was the use of a vertical down pipe barge to deliver sediments to the near bottom location (see Figure 3-5). This alternative was considered as a means to address a maximum impact condition for contaminant mobility and current impacts at the CAD site and was the basis for preliminary design (ABAM, 1985). Use of the downpipe barge was considered to control sediment placement and reduce contact of contaminated sediments in the water column during disposal. Subsequent to the maximum impact assumption, tests were completed by the U.S. Army Corps of Engineers regarding the contaminant mobility (see Section 3.2.3.). Field investigations on currents were also completed (Northern Technical Services, 1986b).

A second disposal option was developed following completion of the field investigations and sediment mobility testing. It was determined that chemical mobility of sediment in the anaerobic or

wetted condition was minor. Further model runs by WES indicated that instantaneous bottom dumping of a 4,000 cubic yard load of in situ contaminated sediments would cover a maximum bed area of 800 x 1,000 feet, given a 265 foot depth and currents as identified by field investigation (Appendix D of the DEISS). This dump would result in a bed cover 0.27 feet thick at the center for each dump. Ninety-eight percent of the sediment load would reach bottom within one hour. With a typical barge dump rate of 3 loads every 2 days for FY 1987 and 5 barge loads every 2 days for FY 1988, the overall water column turbidity impacts would be minimal.

Based on this information and other design recommendations from the U.S. Army (1986a, 1986b, 1986c), the disposal of contaminated sediments by barge dump and subsequent capping with clean materials by hydraulic pipeline dredge or hydraulic pump out barge was developed. The second option has become the basis for design of the CAD site.

Impacts of Dredging and Disposal

Resource agencies have raised concerns on water column impacts and the ability to contain and cap sediments in deep waters. Use of the downpipe appeared to provide an answer to both concerns. However, sediment testing and field measurements along with dump modelling and field experiences provided by the U.S. Army Corps of Engineers and WES indicate the use of a downpipe was not required for water quality protection or for placement control. This analysis and modelling (see Appendix E, pp. 27-28) shows that the same hydraulic and sedimentation processes are present in open barge disposal at depths ranging from 60 to 220 feet. Comparison of predicted sedimentation parameters correlated well with actual field measurements. Consequently, disposal in the somewhat deeper waters at the CAD site is considered to be an extension of existing technology and subject to the same analytical approaches. Physical model results by Engineering Hydraulics, Inc. (1986) indicate that downpipe use would tend to decrease contaminant sediment strength and density, which decreased assurance of successful capping. Clamshell dredging of the contaminated sediments results in having the material delivered to the site in a condition that approaches the in situ density before dredging. Pipeline dredging of the clean sediments to be used for capping results in a sediment slurry that is less dense than the contaminated sediments. Successful capping using pipeline discharge with a downpipe control has been accomplished in actual dredging projects (Port of Portland, Oregon, 1985). Further model tests also indicate impact velocities will not resuspend or displace the contaminated sediments (Appendix B of the DEISS). Based on these factors, the selected disposal approach will utilize bottom dump barges for placement of a mound and contaminated sediments, with clean cover placed by discharge from a pipeline dredge.

The pipeline dredge operation will result in long lines of floating discharge pipe in Puget Sound which may tend to impede routine vessel movement in and out of the harbor. The contractor will be required to provide for vessel movement either by a submerged section of discharge line, or with a pivot barge and a disconnect section of discharge line permit vessel passage with minimum delay.

Site construction is proposed to begin with barge placement of an underwater berm at the downslope project boundary using a portion of uncontaminated sediments in P-111 dredging. The remaining FY 1987 and FY 1988 sediments would be placed sequentially behind the berm upslope.

Dredging common to all proposed disposal alternatives will include excavation in the vicinity of the Scott industrial outfall at the northeast corner of the basin. The final dredge cut will be set back from the outfall so as to avoid damage to that structure.

The proposed Deep Delta CAD site is situated within a portion of the authorized deep draft vessel anchorage area. Future use of the area for the vessel anchorage can result in cap compromise by anchor impact or dragging.

A maximum deposition area expected from barge dump and pipeline disposal operations is provided in Figure 3-10. The areal coverage upon project completion would approach 280 acres. Figure 3-11 provides a cross section perspective of the CAD disposal operation.

Estimated Cost for Confined Offshore Disposal

Unit costs are developed using a clamshell dredge with a 10 cubic yard bucket. The hydraulic dredge is assumed to be a 26 inch discharge pipeline and a 4,000 horsepower pump. The estimated production rates for the clamshell dredge are approximately 5,100 cubic yards per day for contaminated sediments and approximately 6,200 cubic yards per day for uncontaminated sediments. The reduction in rates for contaminated sediments is due to debris separation. The average final cap thickness after consolidation and settling will be 1.4 meters (4.5 feet).

Estimated production rate for the 26 inch hydraulic pipeline dredge is approximately 20,000 cubic yards per day for uncontaminated sediments.

Debris removal and disposal costs are based on sediment disposal at the CAD site with debris trucked to the upland disposal site.

Total estimated cost for the Deep Delta CAD option using the downpipe barge is $18,800,000. Total estimated cost for the bottom dump of contaminated sediments and submerged discharge by pipeline dredge of the uncontaminated sediments is $15,200,000.

3.6.1.2. Southwest Deep Confined Aquatic Disposal Site

Bathymetry and Physical Characteristics

The Southwest Deep Confined Aquatic site is located immediately downslope from the Deep Delta CAD site. The site is relatively flat with a typical 1 on 60 slope. Bathymetric surveys of the site show the depths to vary from 300 feet to 370 feet (Northern Technical Services, 1986a).

A geophysical survey indicates a near surface layer of deltaic sandy silts. The site is covered by a surface layer of marine sediments with a high water content. The northerly one-third of the area is covered by an enriched organic mud, while the southerly two-thirds of the area is identified as a marine mud (Northern Technical Services, 1986a).

Seismic Conditions

Same as for Section 3.6.1.1, Deep Delta CAD.

Currents

Current velocities were taken in the area of this site during PSDDA Phase I studies. Current meter data is also available near the existing Port Gardner disposal site. Interpolation of current data indicates that this site probably experiences water column velocities somewhat higher than the Deep Delta CAD site, but still less than 0.30 feet per second.

Southwest Deep CAD Dredging and Disposal Plan

Construction Schedule

The Southwest Deep CAD site is several thousand feet farther from the dredging location. This will have little or no impact on the clamshell and barge dump operations relative to schedule impacts. The pipeline dredge operation assumed for the Deep Delta CAD operation to dredge and place the uncontaminated capping materi- also will be impacted. The increased length of floating pipeline necessary to reach the site will be difficult to anchor and control. Occasional pipe separation and anchor movement will be more frequent, and with a longer pipeline length, repair and replacement would take longer. As a result, the completion of the FY 1988 dredging could extend beyond the fish window and good weather time periods. It is not practicable to add a second hydraulic dredge to compensate for these time losses.

The risk factor of such long lengths of floating pipeline in open waters could prompt contractors to use clamshell and barge with pumpout systems in lieu of pipeline dredges. Increased project schedule time to complete the dredging would result from this option because of the relatively lower production rate of the clamshell dredge. Additional clamshell, barge and pump-out equipment on the project would compensate for the lower production.

Debris Removal

Same as Deep Delta CAD.

Sediment Removal

For purposes of comparison between alternatives, the sediment removal is assumed to be the same for all CAD site alternatives. Contaminated sediments will be removed by barge mounted clamshell, and uncontaminated sediments removed by hydraulic pipeline dredge or by clamshell with hydraulic pump out barges.

The separation of a pipeline due to inclement weather or other circumstances is not expected to be a common occurrence. Dredging contractors will typically cease operations at the onset of inclement conditions and avoid these type of problems. Based on the pumping distance at the Southwest CAD versus the Deep Delta CAD site, the total production rate of the former would be decreased by approximately 5% due to a decrease in effective pumping time.

For a conservative condition at all the CAD sites, it is assumed that a discharge pipe separation would occur once a day. When the discharge pipe separates, the change in discharge pressure signals the leverman to lift the cutterhead and stop sediment pumping. This will take approximately 2 minutes, resulting in discharge of approximately 70 cubic yards of sediment at the separation point of the pipeline. Based on the proposed schedule and the assumed conservative condition, the inclement conditions to cause a pipe separation would be most probable during the September through November time periods. No delays would occur during the FY 87 dredging under these assumptions. Delays would occur in Fy 88, resulting in misplacement of 5700 cubic yards of sediment.

The selection of clamshell with hydraulic pump out barge may be made by the contractor to avoid difficulties with long discharge pipelines. The pump out barge systems would deliver the sediments to the disposal site as a hydraulic slurry, but at a lesser discharge rate. The contractor must employ additional clamshell equipment for dredging in order to comply with the construction schedule.

Disposal Option

The disposal would be by bottom dump barge for the contaminated sediments. The average depth of disposal would be in 350 feet of water as compared to the Deep Delta site of 280 feet. The revised site topography would result in the primary cause for increased spread of the material on the bed. The deeper depths also will result in minor natural spreading of the sediments due to water entrainment.

Based on application of design criteria and the disposal model results provided by U.S. Army Corps of Engineers (WES), the final capped area for Southwest Deep CAD is estimated at not more than 315 acres in size. This includes a preliminary design for an estimated cap average thickness greater than 1.4 meters utilizing available clean sediments dredged from East Waterway.

Cap development will be closely monitored in progress during both FY 1987 and FY 1988 construction periods to determine the actual need, if any, to provide additional capping materials to satisfy design criteria.

The disposal analysis provided above assumes the same approximate water column velocities as exists at the Deep Delta CAD site.

Impacts of Dredging and Disposal

The Southwest Deep CAD site is farther away from the project dredging. As a result, the project would take longer to complete, increasing the time of disturbance that the dredging causes on natural conditions. The total disposal area impacted will approach 315 acres. An additional dredging volume of clean capping sediments may be required to ensure that an average cap thickness of 4.5 feet is provided over the contaminated sediments. If it is required, this additional sediment requirement could increase the project schedule time frame due to dredging and permit acquisition. Depending on source, borrowing the additional capping sediments by dredging could increase the subtidal area impacted by the dredging.

The proposed Southwest CAD site is situated within a portion of the authorized deep draft vessel anchorage area in Port Gardner. Future use of the area for vessel anchorage can result in cap compromise from anchor impact or dragging.

Estimated Cost for Southwest Deep CAD

Unit costs were developed using a clamshell dredge with a 10 cubic yard bucket. The contaminated sediments would be disposed by bottom dumping. The uncontaminated sediments would be dredged and disposed by pipeline dredge. Debris removal and disposal

costs are based on sediment disposal at the CAD site with debris trucked to the upland disposal site.

Total estimated cost for the Southwest Deep CAD option, excluding dredging of any additional for capping, is $16,500,000.

3.6.1.3. Revised Application Deep Aquatic Disposal Site

Bathymetry and Physical Characteristics

The Revised Application Deep CAD site is located immediately downslope from the Southwest CAD site. It is south and west of the preferred PSDDA disposal site center a distance of approximately 5000 feet and approximately 3000 feet from the periphery. The site is relatively flat with typical bed slopes ranging from 1 on 35 to 1 on 60. Bathymetric surveys of the site show the depths to vary from 310 feet to 430 feet (Northern Technical Services, 1986a).

A geophysical survey indicates a near surface layer of deltaic sandy silts, identified as a marine mud (Northern Technical Services, 1986a). These marine sediments have a high water content.

Seismic Conditions

Same as for Section 3.6.1.1, Deep Delta CAD.

Currents

Current velocities were taken at this specific site during PSDDA Phase I studies. Current meter data are available for the Port Gardner site immediately adjacent this site. Interpolation of current data indicates that this site experiences water column velocities somewhat higher than the Deep Delta CAD site, but still less than 0.30 feet per second.

Revised Application Deep CAD Dredging and Disposal Plan

Construction Schedule

The RAD CAD site (Figure 11b) is approximately 2000 feet farther from the dredging location than the Southwest CAD site. This will have little or no impact on the clamshell and barge dump operations relative to schedule impacts. As with the Southwest CAD site, the increased length of floating pipeline required to reach the disposal site will be difficult to anchor and control. Occasional pipe separation and anchor movement will be possible resulting primarily in increased non-effective pumping time for the work. Pipe separations will also mean potential displacement of sediments.

Discussion of the contractor concerns about this longer floating pipeline length was provided in discussion of the Southwest Deep CAD site, section 3.1.6.1.2.

The separation of a pipeline due to inclement weather or other circumstances is not expected to be a common occurrence. Dredging contractors will typically cease operations at the onset of inclement conditions and avoid these type of problems. Based on the pumping distance at the RAD CAD versus the Deep Delta CAD site, the total production rate would be decreased by approximately 12 percent due to a decrease in effective pumping time. The increased pumping distance for the RAD CAD site requires the use of a booster unit in the discharge line which also contributes to the increased non-effective dredge time for this alternative.

For a conservative condition at all the CAD sites, it is assumed that a discharge pipe separation would occur once a day. When the discharge pipe separates, a change in discharge pressure signals the leverman to lift the cutterhead and stop sediment pumping. This will take approximately 2 minutes, resulting in discharge of approximately 70 cubic yards at the separation point of the pipeline. Based on the proposed schedule the inclement conditions to cause a pipe separation would be most probable during the September through November time periods. No delays would occur during the FY 87 dredging under these assumptions. Delays would occur in Fy 88, resulting in misplacement of 5700 cubic yards of clean capping sediment.

The estimated dredging schedule for the RAD CAD site given below, assuming a dredging start date of June 15 in FY 1987 and FY 1988.

FY 1987	Start Dredging	June 15, 1987
	Complete Berm	July, 1987
	Complete Contaminated	August, 1987
	Complete Cap, first lift	August, 1987
	Complete Dredging	September, 1987
FY 1988	Start Dredging	June 15, 1988
	Complete Contaminated	September, 1988
	Complete Cap, first lift	October, 1988
	Complete Dredging	November, 1988

Debris Removal

Same as Deep Delta CAD

Sediment Removal

For purposes of comparison between alternatives, the sediment removal is assumed to be the same for all CAD site alternatives.

Contaminated sediments will be removed by barge mounted clamshell, and uncontaminated sediments removed by hydraulic pipeline dredge or by clamshell and hydraulic pump out barge.

Disposal Option

The disposal for the berm would be by bottom dump barge. The sediments would be the clean sediments located to the south and west of the proposed breakwater and carrier pier. The average depth of the berm is at 400 feet, and would cover approximately 120 acres of bed area.

Disposal for the FY 1987 and FY 1988 contaminated sediments would be by bottom dump barge. The FY 1987 disposal will be in average depths of 380 feet and cover approximately 50 acres of bed and berm area. The FY 1988 contaminated disposal will be in average depths of 340 feet and cover approximately 80 acres of bed and FY 1987 capping sediments. Dredging and disposal for the FY 1987 and FY 1988 capping sediments will be by pipeline dredge or by barge pumpout.

Both pipeline dredge and barge pumpout methods deliver the capping sediments to a specified elevation and horizontal position as a homogeneous slurry of approximately 20% to 40% in situ sediments by volume. The pumpout barge system will deliver the sediments at a lower discharge rate than the pipeline dredges. Application of pumpout barges will require the contractor to employ more than one clamshell for dredging to meet the existing construction schedule.

The cap sediments will be placed as a submerged slurry discharge to assure uniform capping and avoid displacement of contaminated sediments. The capping will be accomplished with a two lift minimum requirement to assure early cover of the contaminated sediments and avoid creation of a mud wave displacement of those sediments. The FY 1987 will cover a total area of approximately 120 acres and will be approximately 10 feet thick at the end of dredging. This is in a suspended, bulked condition and the cap sediments will consolidate to approximately 5 feet thickness before the 1988 dredging effort. The FY 1988 disposal for cap will cover the FY 1988 contaminated, the FY 1987 cap and a portion of the downslope berm, or approximately 280 acres. The design thickness is 10 feet bulked over the FY 1988 contaminated. Total area of coverage for the two years disposal will be approximately 380 acres. This is expected to consolidate to a long-term thickness of 1.4 meters (4.5 feet).

Design of the mound spread has been accomplished using conservative design criteria for the sediment characteristics and the water column currents. The overall size of the disposal site is governed by the amount of material being placed, sediment bulking factors, material characteristics that govern stable side slopes

of the disposal mound, effects of bottom slopes, and settlement characteristics. Since the deposition area of each individual barge disposal is small (20 acres) relative to the overall site size (300 acres), the total area of all barge dumps can be controlled by positioning of the individual dumps. Control of the capping slurry discharge is a function of discharge point location and dredge production rate. These parameters will be varied as required while the cap placement progresses.

Assuring accurate placement of the material will require monitoring of the discharge or dump position, and development of the actual mound on the bed.

Impacts of Dredging and Disposal

The Revised Application Deep CAD site is at a distance from the dredging area that a booster unit is required. Increased time to complete the project is expected, increasing the time of disturbance that the dredging causes on the natural conditions. Probability for accidental misplacement of dredged sediments is increased for the clean sediment disposal. The contaminated sediment disposal is relatively unchanged.

The RAD CAD is within 3000 feet of the preferred PSDDA site. Concurrent dumping of materials at the RAD CAD and PSDDA site could result in difficulty for ongoing monitoring efforts at either site. The two sites are adequately distant that significant impact of one site by the other is not to be expected. Control of disposal position at both sites as proposed at the RAD CAD site is necessary to avoid monitoring complications, and future impacts after completion of Homeport dredging.

A potential for additional mass loss of clean dredge sediments does exist due to discharge pipe separation. This is estimated on a conservative case basis at 5,700 cubic yards. The proposed RAD CAD site is situated outside of the authorized deep draft vessel anchorage area in Port Gardner. No impacts are anticipated for this site due to anchor impact or dragging.

Assuring final cap thickness is a major consideration for the project, inadequate cap thickness is corrected by placing additional sediments to provide necessary cover. An additional 300,000 cubic yards of clean, fine grained sediments can be obtained from overdepth dredging in the project area in the berth between the breakwater and the Carrier pier. This dredging could be included as a contract option in the FY-88 plans and specifications or added as a contract modification at the end of the project. If it is required, this would lenthen the project schedule due to dredging and permit acquisition.

Estimated Cost for Revised Application Deep CAD

Unit costs were developed using a clamshell dredge with a 10 cubic yard bucket, a 26 inch pipeline dredge with booster unit in the discharge line. Debris removal and disposal costs are based on sediment disposal at the CAD site with debris trucked to the upland disposal site. These costs reflect competitive bids from contractor and are representative of either pipeline or pumpout barge contractor options.

Total estimated cost for the Revised Application Deep CAD option, excluding dredging of the additional 300,000 cubic yards for capping, is $17,500,000. If required, the additional 300,000 cubic yards would increase the RAD CAD option by approximately $1,200,000.

3.6.2. Unconfined Open Water Disposal

3.6.2.1. Port Gardner

For the purpose of this EISS the existing Port Gardner site is being evaluated for disposal of uncontaminated dredged sediments only. No debris or contaminated sediments would be disposed at this site. The site will be used in conjunction with confined disposal of contaminated sediments at the East Waterway, the Snohomish Channel or the Smith Island disposal sites. The Port Gardner disposal site is administered by the Washington Department of Natural Resources; the permit renewal for continued use is pending local government approval.

Bathymetry and Physical Characteristics

The Port Gardner site is an existing site, previously approved for open water disposal. The site is located 1.9 miles south and west of the project site, approximately one-half mile offshore. The site is approximately 1,800 feet in diameter. (See Figure 3-8.)

The seafloor deepens toward the north. Seafloor depths vary from approximately 280 MLLW to 380 feet MLLW. The floor generally slopes at a constant rate of approximately 20 feet horizontally to one foot vertically.

Geotechnical Characteristics

The Port Gardner site is an open water site at which bottom dumping disposal of relatively uncontaminated sediments has been accomplished in the past. As an established site, geotechnical considerations do not appear to have an effect on operation.

Port Gardner Dredging and Disposal Plan

Construction Schedule

This site will not require any special preparation prior to disposal of uncontaminated sediment. Current velocities in the area are weak and material will settle within the disposal area.

Sediment Removal

Utilization of the Port Gardner site is straightforward and consistent with in-water disposal methods currently used at the site and elsewhere in Puget Sound. Sediments from the project site will be dredged by barge-mounted clamshell dredge and placed on a bottom dump barge. The barge would be towed or pushed to the Port Gardner site and dumped. Positioning the disposal barge at the site will be done by the use of an electronic positioning system to assure accurate placement.

The clamshell dredge for this operation is assumed to be a 15 cubic yard dredge bucket for the purpose of analysis. The bottom dump barge is assumed to have a capacity of 4,000 cubic yards.

Hydraulic dredging and disposal to the site by pipeline is feasible but not considered as economical due to the requirement for use of long floating discharge lines in relatively open waters.

Disposal Options

The Port Gardner site has one constraint affecting its use for disposal of sediments from the homeporting construction: it can be used only for disposal of uncontaminated sediments.

Dredging associated with use of the Port Gardner site will occur after debris and contaminated sediments are removed from East Bay. The dredging of uncontaminated sediments will immediately follow debris and contaminated sediment removal.

Based on a production rate of 9,300 cubic yards per day, a single barge mounted clamshell dredge with several bottom dump barges could complete the P-111 uncontaminated dredging in three months. The P-905 and P-112 uncontaminated dredging could be completed in six to seven months with a single clamshell dredging unit. This time could be reduced to less than four months if two clamshell dredges were used on site.

Estimated Cost of Port Gardner Site

The estimated production rate for disposal of material at the Port Gardner site is 9,300 cubic yards per day, or 55,800 cubic yards per week. The rate is based on the use of the equipment discussed above working three shifts per day, six days per week. Production rates can be increased by using more than one clam-

shell dredge. Unit cost estimate for the placement of uncontaminated sediments at Port Gardner is $3.31/cy.

3.6.3. Nearshore Disposal

As earlier defined (Sect. 3.1.6) the nearshore option involves maintaining contaminated sediments in a saturated condition below groundwater levels. Available data indicates that the effective groundwater level at the nearshore sites considered is at about elevation +7 feet (Mean Lower Low Water). Storage capacity estimates for these sites is based on this level. However, it should be noted that final design would be preceded by field investigations to document the sites' specific groundwater regime as a basis for final design and capacity calculations.

3.6.3.1. Snohomish Channel Intertidal Site

An intertidal area on the Snohomish River approximately 1.5 miles upstream from the project site has been identified as a potential area for disposal of contaminated and uncontaminated sediments and all of the debris removed during construction of the Homeport. The site has not previously been used as a dredge disposal site, although it is situated between two previously filled sites. Use of the site will require the construction of containment dikes prior to the placement of dredge sediments. Major considerations for design of this site are methods of retention and disposal volume.

Two alternatives are under consideration for use of the Snohomish Channel site. One alternative designates the site to receive all dredged sediments. The second alternative combines disposal of all or portions of the contaminated sediments not disposed at the East Waterway site (see Section 3.6.3.6.). Under the second alternative the remaining uncontaminated sediment would be disposed at either the Port Gardner or CAD sites.

Physical Description

The Snohomish Channel Intertidal site is located approximately 1.5 miles upstream from the project site on the east shoreline of the Snohomish River channel (see Figure 3-12). The site totals approximately 180 acres and is presently used for log storage. It is part of an intertidal mud flat although adjacent lands have been filled for industrial and recreational development. The slopes of these filled areas are riprapped and form an irregular site boundary.

Site elevations range from -2 feet MLLW to +5 feet MLLW and vegetation is determined by topography. Salt marsh vegetation is established in the higher elevations from the mud flat to the sloped dikes, while algae forms the basis for vegetation in the lower, wetter areas.

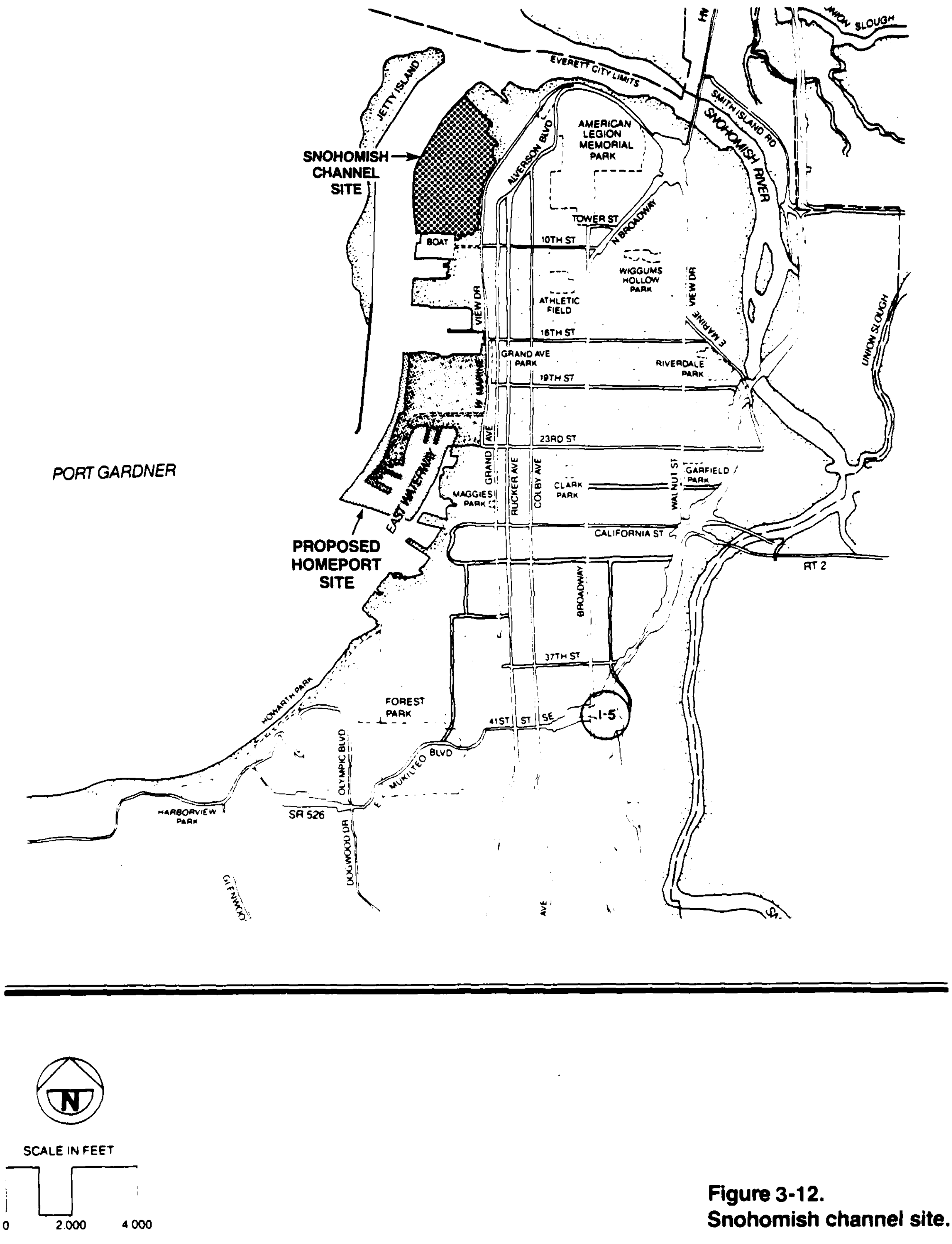


**Figure 3-12.
Snohomish channel site.**

The mud flats of the Snohomish estuary are inhabited primarily by small polychaete worms and crustaceans. Other invertebrates common in this habitat are insect larvae in some locations. A survey of the benthos inhabiting portions of the proposed site showed fauna to be somewhat different that other mud flats in the estuary (Everett Planning Department, 1980). The site supported large numbers of small tanoidaceans and minute harpacticoids. A few corophium were found in the samples from the log raft area. Juvenile salmon may be present on site during the spring and early summer. In addition to salmonids, the proposed site may be used by several other species of fish, but the high tidal elevations make this site generally unsuitable habitat for all fish except those that move in and out with the tides and occupy extremely shallow water. The high tide flats do provide a habitat used by a wide variety of birds.

Geotechnical Characteristics

Subsurface conditions at Snohomish River site are believed consistent with those encountered throughout the general homeport site: deltaic deposits of silty sand, sandy silt and clayey silt. These soils have moderate to low strength and moderate to high compressibility.

Containment dikes will be required for disposal of dredged sediments. Slopes of 2:1 adjacent the river channel and 5:1 elsewhere are anticipated. Fill settlement at the Snohomish Channel site is expected to be as much as five feet during the first five years. As much as one to two feet of this settlement could occur in the first six months after dike construction and fill placement. The dike slopes and the fill settlement values are derived from actual construction experience during Norton Terminal development which is immediately adjacent the proposed site.

Seismic Conditions

Same as Section 3.6.4, Smith Island.

Snohomish Channel Dredge and Disposal Plan

Debris Removal

Debris will be removed from the project site by a barge-mounted clamshell and deposited on a barge. The material will be transported to Snohomish Channel where it will be transferred from the barge into the site by upland crane. For purposes of this evaluation, the clamshell dredge is assumed to use a 10 cubic yard dredge bucket.

Sediment Removal

Contaminated sediments will be removed by a hydraulic pipeline dredge and directly discharged behind the containment dike to an elevation +7 feet MLLW. For the purpose of this evaluation a 26 inch discharge pipeline and a 4,000 horsepower pump is assumed. Production rate is estimated at 16,300 cubic yards per day.

A cap of uncontaminated sediments will be deposited on top of the contaminated material to an elevation +18 feet MLLW. It can be expected that the site will remain wet and unusable for a number of years unless specific steps are taken to dewater the uncontaminated, capping sediments. Such steps may include trenching by lightweight vehicle or helicopter assisted methods and would accelerate the consolidation of surface materials.

The need for accelerated cap dewatering will depend on progress of natural draining and future plans for site use.

Uncontaminated material will be dredged from the project site using hydraulic pipeline dredge equipment with direct discharge to the Snohomish Channel site. This evaluation assumes a 26 inch discharge pipeline and a 4,000 horsepower pump. Production rate for the 26 inch pipeline dredge is estimated at 22,000 cubic yards per three-shift day for uncontaminated sediments.

Disposal Option

Containment diking concepts have been developed based on requirements for disposal of contaminated, uncontaminated, and/or debris materials. One concept assumes the site will receive all the sediments and debris dredged from the project. The other concept utilizes other disposal areas for the uncontaminated sediments and places debris and contaminated sediments at the Snohomish Channel site with an uncontaminated cap over the material.

Two containment area dike alignments have been developed. For disposal of all materials, 155 acres are required for containment. The alternative disposing of contaminated sediment only requires 100 acres for containment and a cap of uncontaminated sediment. See Figures 3-13 and 3-14.

Dikes will be constructed of imported materials to elevation +21 feet MLLW. Effective height is considered to be +20 feet MLLW and assumes sufficiently fine material in the top of the dike to control turbid leaching from the settlement pond. The +20 foot elevation allows sufficient freeboard and ponding area during construction. Dike slopes will be 2:1 or steeper.

To allow for disposal of all dredged materials at Snohomish within the FY 1987 and FY 1988 dredging window schedule, and to assure all contaminated sediments are placed below the +7 foot

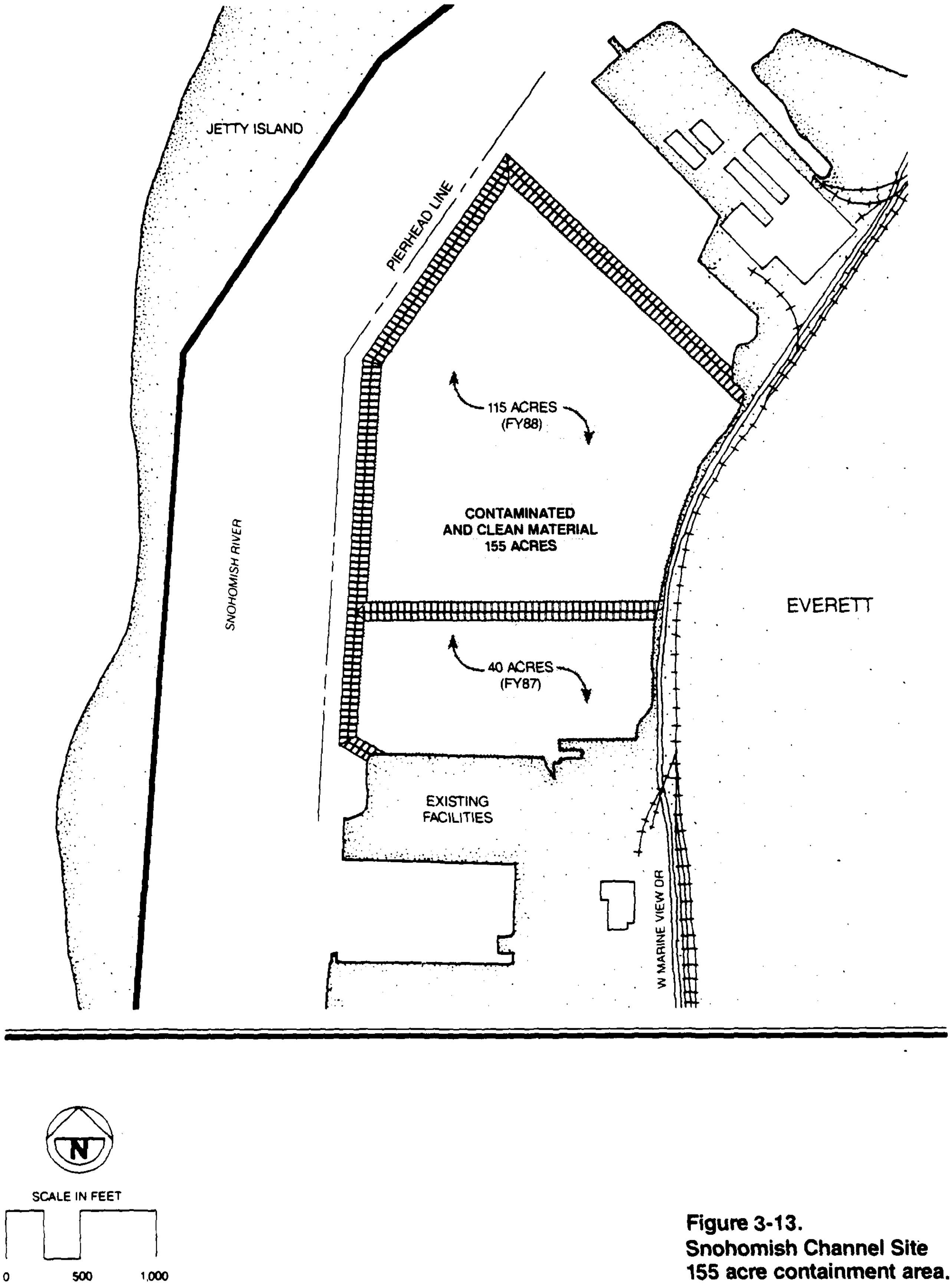


Figure 3-13.
Snohomish Channel Site
155 acre containment area.

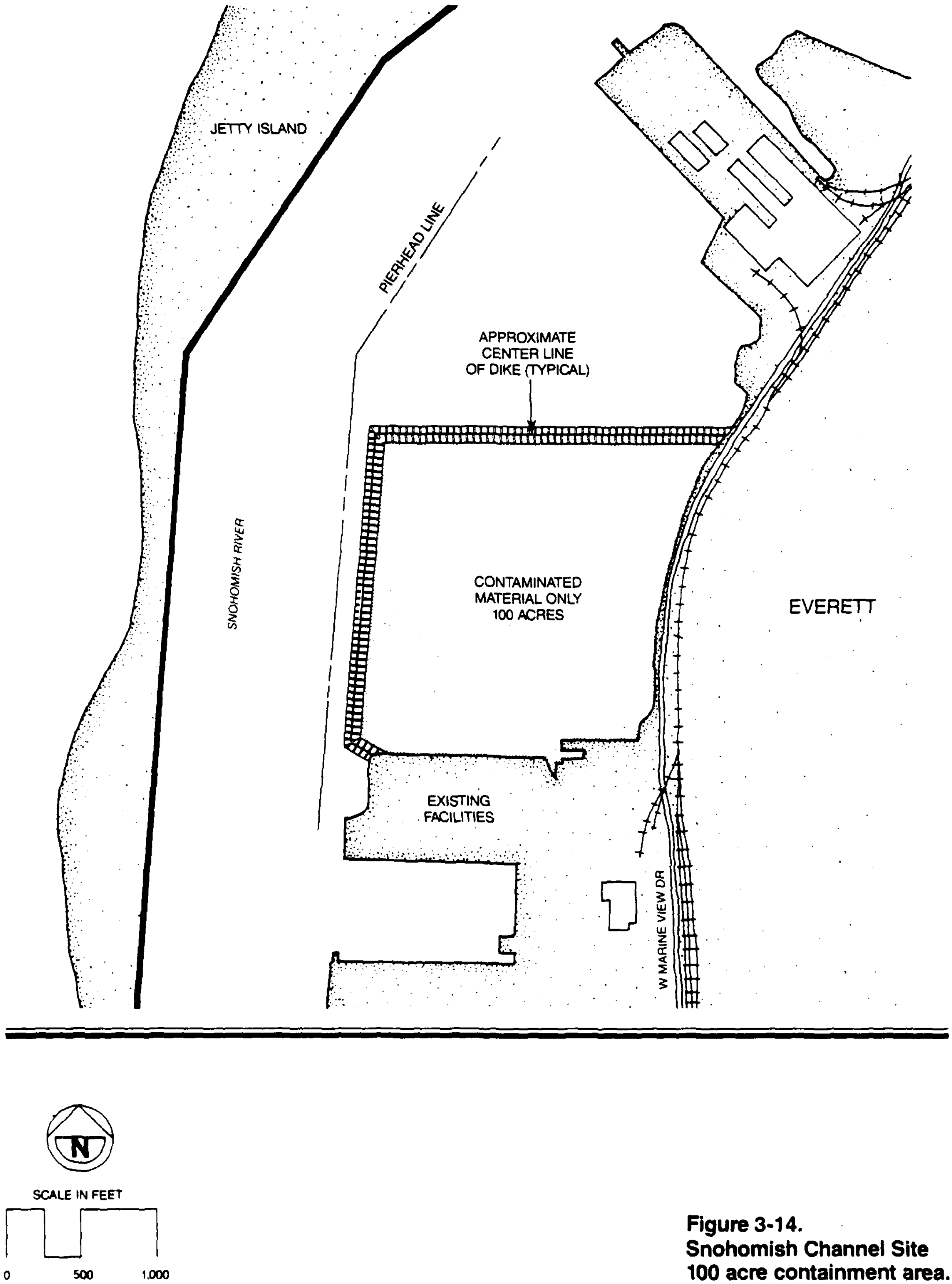


Figure 3-14. Snohomish Channel Site 100 acre containment area.

elevation, dikes will be arranged to create two cells. The first cell will be constructed to receive the dredged sediments from the P-111 contract; sediments from P-112 and P-905 contracts will be designed for the second cell. The outside dike on the river side will require revetment for protection.

Based on tests of the contaminated material, it is not anticipated that impervious liners will be required in the disposal area or along the dikes since the contaminants are predominantly sediment bound if sediments are kept saturated (Appendix D of the DEISS).

Construction Schedule

The construction of dikes must be accomplished prior to dredging contaminated sediments. It is anticipated construction will take 4 months to complete and 2 additional months for consolidation. If permitted, the small berm area for FY 1987 materials can be completed in time for FY 1987 dredging of contaminated sediments (see Figure 3-13). This will require work into and through the fish window months. If construction is not permitted, the actual site non-availability, allowing 4 months construction and 2 months consolidation, will delay dredging and subsequent carrier pier construction. As a result, carrier birthing would be delayed approximately 1 year.

Impacts of Dredging and Filling

A loss of approximately 150 acres of intertidal and 5 acres of adjacent wetlands will result from dredging and disposal operations. Disposal area sizing, design of weirs and spillways in accordance with accepted criteria and specification of an allowable mixing zone should result in meeting or exceeding standards established for turbidity, suspended solids, and contaminants in the water returning to the river. Water quality can be continually monitored and variance from standards mitigated by curtailing dredge operations for periods (such as one shift per day) to allow more ponding/settling time for the slurry. It is assumed that the normal March 15 to June 15 fisheries window shutdown period is required.

Snohomish Channel Estimated Cost

Cost estimate for the Snohomish Channel site includes dike construction, removal of all debris and dredged sediments and land acquisition. The cost estimate to dispose all sediments at the site, requiring 155 acres, is $24,101,000. The alternative cost estimates to dispose only the contaminated sediments at the Snohomish Channel site, requiring 100 acres, with remaining sediments going to the CAD site or to Port Gardner, are $18,890,-000 and $20,823,000 respectively (Appendix C of the DEISS).

3.6.3.2. East Waterway Site

The East Waterway site is being considered for disposal of debris and contaminated materials. Major considerations for site design include encroachment on turning basin requirements, retention methods, disposal volume, existing structures and future use of the site.

Physical Description

The East Waterway site is located at the northern and eastern edges of the East Waterway (see Figure 3-8 for location) and has historically been used for shipping and log handling. Existing uses include the Scott Paper Company industrial water treatment facilities and the Naval Reserve Center pier and facilities.

Site elevations vary from +15 to -36 MLLW. It receives waters from upland storm drain systems and the Scott Paper Company treatment plant. The outfall system from the treatment plant is located in the northeast portion of the disposal area.

Geotechnical Characteristics

Subsurface conditions at the East Waterway site are generally consistent with those encountered at the general homeport site. Soils consist of deltaic deposits of silty sand, sandy silt and clayey silt. These soils have moderate to low strength and moderate to high compressibility.

Settlement of the dredged fill area is expected to range between eight and twelve feet with as much as two feet occurring before construction is complete. These settlement values consider both foundation settlement and consolidation of dredge sediments.

Groundwater levels have a significant impact on site storage capacity. WES studies demonstrate that contaminants remain relatively sediment bound if maintained in a saturated condition. To remain saturated, contaminated material should be placed no higher than groundwater elevation. Present indications are that the groundwater level at the site is independent of tidal fluctuation and is at or above elevation +7.

Seismic Conditions

Same as Section 3.6.4, Smith Island.

East Waterway Dredging and Disposal Plan

Construction Schedule

Containment dikes will be required prior to utilizing the site for disposal. Large earth retaining structures would be diffi-

cult to construct at the site due to soft, deep soils with propensity for large settlement. Fills are prone to slides and lateral earth pressures are high. Careful consideration was given during the design phase to select the optimum feasible containment structure. Two options were selected; 1) a full-height berm with 3:1 slopes and staged construction and 2) a berm with retaining wall, constructed to +10 feet MLLW with imported rock fill and 3:1 slopes. Each option has +19 feet MLLW as finished grade shoreward and -42 feet MLLW as final dredged depth seaward. General plan alignment is perpendicular to the northern end of a future central marginal wharf, east 630 feet, then southeast to the existing shore (See Figure 3-15).

The critical item in construction schedule for the homeport facility is the carrier pier piling, which must begin no later than mid-July 1987. Prior to this, dredging the carrier pier must begin in mid-June, and the disposal site must be ready before dredging begins. Commencement of the fish window in mid-March limits available construction time from issuance of the notice to proceed. The notice to proceed, expected in January 1987, results in only a 10 week construction window on the retention berm before the fish window closure. The retention berm construction has been estimated to take approximately 8 months (ABAM, 1986) with a 2 month period required for berm settlement and densification prior to dredging and disposal. Given this 40 week construction effort for the berm the FY 1987 sediment dredging of overburden contaminated and subsurface clean sediments for P-111 would be delayed until February 1988. Delays in dredging would delay pile driving and subsequent dock and wharf construction. This delay coupled with maintaining the fish window closure would mean the proposed December 1988 carrier berthing would be delayed approximately 10 months. The feasible alternative structure will take much longer to construct than allowed from January through mid-March. Therefore the dredging activity would be delayed pending the East Waterway site availability.

Debris Removal

Debris will be removed by a barge-mounted rake, deposited on a barge and transported to the upland disposal site by truck.

Sediment Removal

Contaminated and uncontaminated materials are proposed to be removed by hydraulic pipeline dredge. Contaminated sediments will be deposited directly into the containment structure to elevation +7 (Mean Lower Low Water). Uncontaminated material will be deposited on top of the contaminated material to form a cap to elevation +18. During construction, temporary berming will be placed to +20 elevation on the containment structure to provide adequate ponding freeboard.

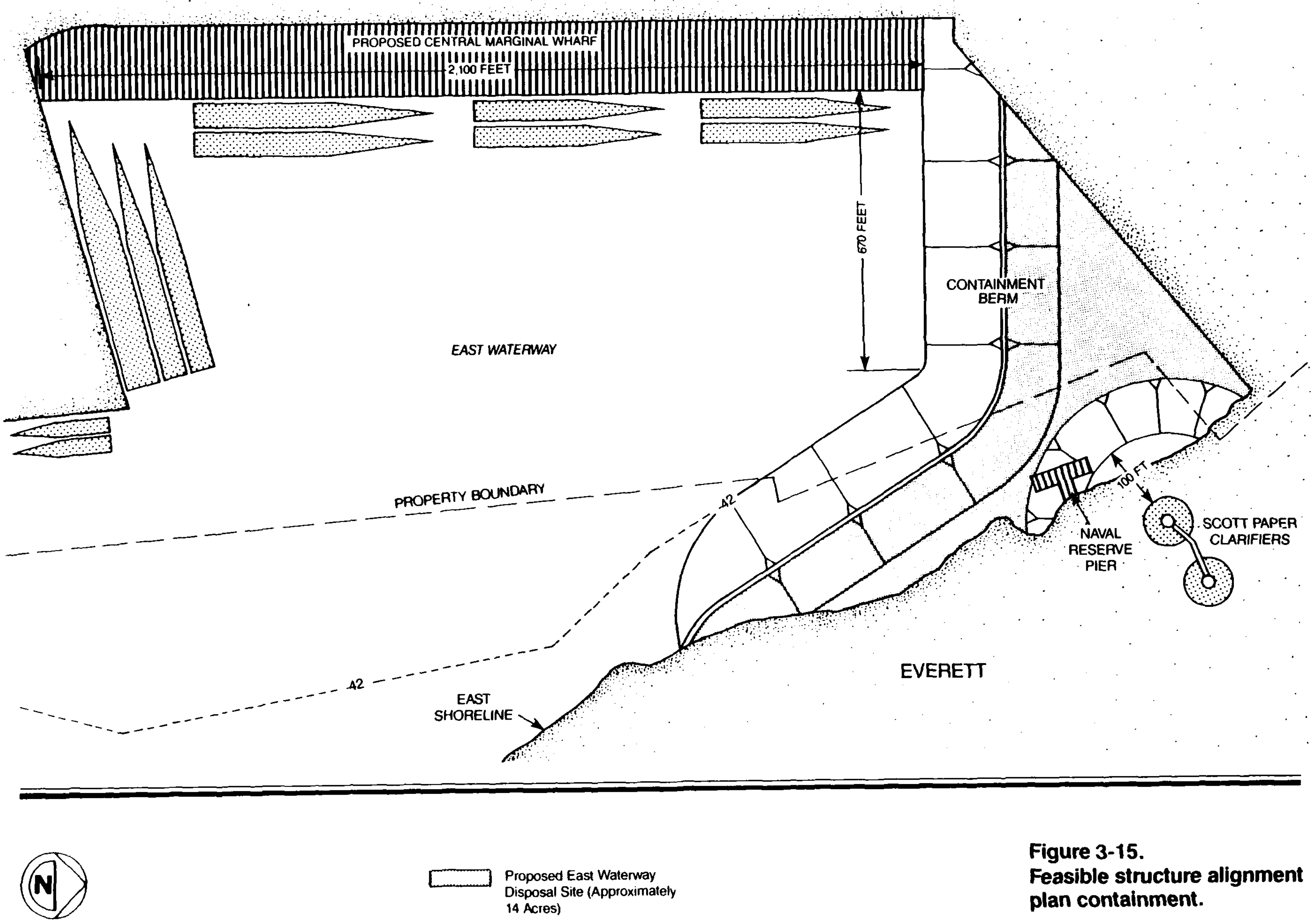


Figure 3-15.
Feasible structure alignment plan containment.

Evaluation of the East Waterway disposal site capacity considering design criteria indicates that the site cannot provide adequate retention time for the sizes and production capacities of a hydraulic dredge operation necessary to meet practical dredging schedules and costs. Site capacity using the full height berm containment option is 287,000 cubic yards of contaminated cover material and 125,000 cubic yards of uncontaminated material. Minimum retention time considering containment structure alignment will be achieved if a 12 inch pipeline dredge is used instead of a 26 inch pipeline dredge. Assuming the remainder of the contaminated sediments go to the Snohomish Channel site, or the Smith Island site, the use of a 26 inch hydraulic dredge is also required. This combination means either mobilization of two dredges or significant noneffective time for one large dredge in order to meet water quality requirements.

Disposal Options

The objective of the retaining structure is to maximize the dredged sediment capacity. Nine retaining structural concepts were studied for constructability, sediment volume, cost and schedule issues. The only retaining structure considered marginally acceptable from a volume storage capacity and a sound geotechnical, structural design was the retention berm structure with a 3 to 1 slope or less (ABAM 1986). Due to low foundation strength and the large fill depth (approximately 60 feet), this design does have a high potential for liquefaction and subsequent failure of the berm immediately following construction and dredge disposal of sediments as a slurry behind the berm. Up to several years' time will be required to allow eventual settlement of the berm substrate and dewatering with natural settling of the dredged material to alleviate this potential. A structural design risk does therefore exist even with this acceptable alternative during both construction and for several years following the dredging activity.

Two plan alignments for the retention berm structure were analyzed. The variable factor controlling the berm alignment was the length of the berth at the central marginal wharf. The first plan identified in Figure 3-15 considers a central marginal wharf of 2100 feet. This alignment provides minimum adequate berthing for fleet requirements. The containment area provides an approximate 14 acre disposal site which does not have adequate volume capacity for all of the contaminated sediments..

The second plan alignment was moved south to provide necessary capacity for disposal of all of the contaminated sediments. With this plan the central marginal wharf will be 1700 feet long, resulting in inadequate fleet berth requirements. This plan provides an approximate 20 acre disposal site. See plan 4-15a.

Both retention berm designs will be approximately 1700 feet long, require over 1 million tons of imported granular fill and will require approximately 40 weeks from initiation of construction to actual use as a disposal site. The first plan must include a second disposal site to satisfy contaminated volume disposal requirements. As a supplement, the Snohomish Channel site would receive the remaining contaminated materials, be capped with uncontaminated sediments and require approximately 85 acres of land for dike construction and disposal placement. The Smith Island site is also considered a feasible second disposal site.

Impacts of the Dredging and Filling

Significant effects on adjacent structures, existing and planned, can be expected from settlement of the large quantity fill. Design calculations indicate that structures 150 feet from the average edge of fill could experience differential settlement of up to 1/2 inch.

A major effect will be on the Scott Paper Company clarifier tank and outfall, located at the northeast portion of the site. The outfall will require relocation if the East Waterway site is used for disposal. Relocation cost for the outfall is estimated to be $500,000 (ABAM,1986). Potential settlement in the vicinity of the Scott Paper clarifier ponds requires special design consideration. To assure no impacts on the clarifier ponds, an interior dike construction has been allowed to prevent overburden loading and settling of the clarifier pond. This reduces the total site volume capacity for both retention berm alignments which has been incorporated in the site analysis accordingly. Also affected will be the Scott Paper Company wharf which would experience downdrag loads on the structure's pilings.

Dredge fill settlement could be expected to adversely impact adjacent facilities to the north. Future wharf facilities could also be affected by settlement from the fill, which could continue for several years.

Based upon the design criteria provided by the Waterways Experiment Station and the viable containment option, the East Waterway site cannot provide adequate retention time for a hydraulic pipeline dredge operation.

East Waterway Site Cost Estimate

Assuming the retention wall is constructed to allow disposal of all contaminated sediments at the East Waterway site, and all uncontaminated sediments to the Port Gardner site, the future central marginal wharf length will have to be reduced from 2,100 feet to 1,700 feet. Estimated cost is $26,347,000. Retaining the central marginal wharf length of 2,100 feet, and assuming the remaining contaminated material goes to an 85 acre, diked

Snohomish Channel site, the estimated cost is $35,919,000. This latter cost includes preparation of both the East Waterway site and the Snohomish River site. The cost estimates include dredging and disposal of uncontaminated sediments at Port Gardner, and relocation of Scott Paper Company outfall.

3.6.4. Smith Island (Upland Option)

The Navy FEIS identified several upland sites located on Smith Island and one located north of Smith Island on the Tulalip Indian Tribe property. Evaluation of these sites in the context of the final dredging quantities, distance from the dredging site, accessibility, adequate size and existing use suggests that the Smith Island sites designated as 2 and 4 are of the greatest interest, and could be considered feasible as an upland site. Location of the Smith Island site is shown in Figure 3-8.

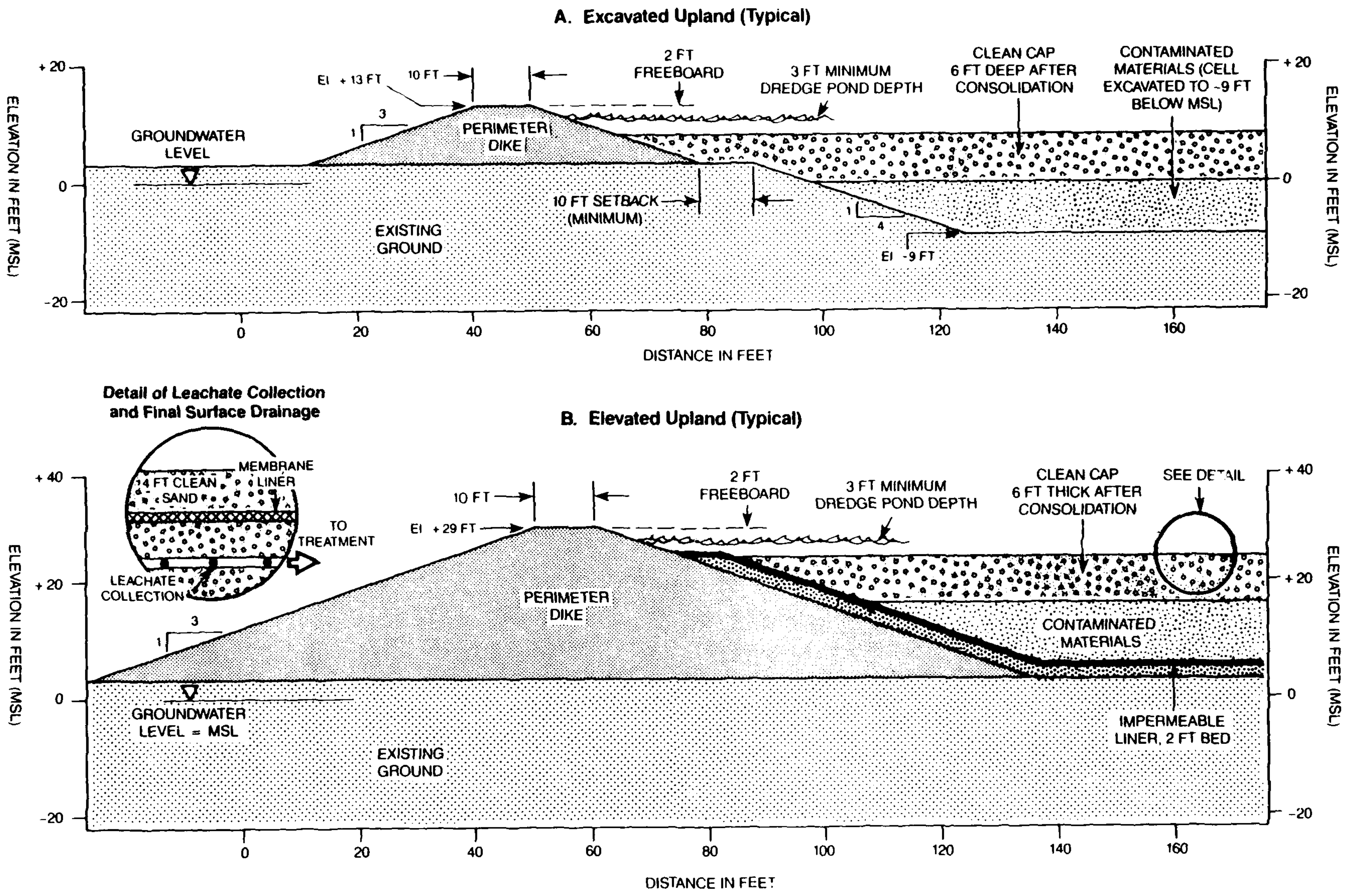
Additional site field investigation and analytical studies have been completed since the Navy FEIS. These include land survey, geotechnical investigations and assessment of the site wetland conditions. Based on these and other data, a feasibility study of Smith Island upland disposal concepts was conducted and is included as Appendix C.

Physical Characteristics

The Smith Island site as now identified is located on the north edge of Smith Island adjacent to the Steamboat Slough and Union Slough channels. The site is a distance of 4 miles north of the project site. The total site includes an approximate area of 110 acres in surface area bordered by the Burlington Northern Railroad on the East, the Steamboat Slough channel on the north, the old log basin tidal slip and intertidal wetlands on the west and a shallow drainage slough meander on the south (See Figure 3-16).

The property is included inside a diked portion of Smith Island and has a low dike structure along the north and west boundaries of the site property. Existing dike top elevations are at 9 feet Mean Sea Level (msl) typical along Steamboat Slough with a low point elevation at 4 feet msl on the westerly edge of the property. Existing ground elevations range from 1.0 feet msl on the east to 7.1 feet msl on the west, with an average elevation near 3 feet msl. Note: Add +6.5 feet to msl elevations to obtain elevations referred to Mean Lower Low Water (mllw); e.g., 9 feet msl is 15.5 feet mllw.

The easterly 65 acres of the site is pasture land. The remaining west portion of the site has been filled with coarse grained sediments for the previous use as a log storage and sorting area. An area of approximately 1/4 acre in the southwest portion of the 110 acres has been identified by the U.S. Army Corps of Engineers



Note Elevations referenced to mean sea level (MSL)
Add 6 5 feet to MSL elevations to obtain
mean lower low water (MLLW) elevations

**Figure 3-16.
Smith Island Upland
Disposal Concepts.**

as a wetland (Wetland Determination, U.S. Army Corps of Engineers, 30 September, 1986, see Appendix C). The drained condition of the remainder of the site has been sufficient to preclude the presence of either a predominance of hydrophytic vegetation or a hydrologic regime over most of the site.

Seven different areas were identified on the site, based on plant association and dominance. Two areas were pasture land with a predominance of quack grass, kentucky bluegrass, timothy and common orchard grass. A swale area was revegetated by soft rush, cinquefoil, smart weeds and reed canary grass. The abandoned log yard was dominated by velvet grass, clover, some scotch broom, and young red alder. The wetland was predominantly rushes and smart weed. Blackberries, thistles and a few spruce trees covered the remaining areas. During site visits, various species of birds were seen including red tailed hawks, northern harrier, sparrows, gold finches, gulls and ducks.

Geotechnical Characteristics

Subsurface borings were obtained to typify the sediments in the site (Hart-Crowser, October, 1986b, see Appendix C). The subsurface soil conditions as disclosed by the limited soil data are summarized:

- Surface 2 to 3 feet of sediments are composed of medium stiff, organic silt. This layer appears to be capable of supporting light to moderate construction traffic.

- The medium stiff surface layer is underlain by 6 to 20 feet of very soft, wet, organic clayey silt with pockets of peat and sand seams.

- The soft, clayey silt subsurface sediments are in turn underlain by medium dense silty sand and sand to depths of at least 50 feet.

Consideration of subsurface conditions was given for containment dike design. Slope stability analysis indicated that dike slopes of 3H on 1v or flatter provide a conservative design for structure foundation stability. Alternatively, steeper slopes might be used in conjunction with rock underlayment and/or staged construction. Some limited settlement of the containment dike is to be expected due to consolidation of the underlying soft sediments. The amount of settlement is not judged significant provided the flatter dike slopes are maintained for design (see Appendix C).

The general groundwater conditions at the Smith Island site is characterized by groundwater at mean sea level (msl), or approximately 6.5 feet mllw, which is hydraulically connected to tidal fluctuations and seasonal variations in precipitation and

discharge by the surrounding surface waters. Ground water measurements indicate the majority of the site will have groundwater elevation equal to mean sea level with minor variations. More significant variations are to be expected adjacent to the waterways due to tidal fluctuations.

Groundwater flow velocities are expected to be fairly low, especially in the upper silt layers due to low permeability of the soils and low hydraulic gradients at the site. Groundwater quality samples were taken from the boring holes for laboratory analysis of selected parameters of concern identified from the U.S. Army Corps of Engineers Technical Report (Appendix D, DEISS). Field test parameters indicate the pH values were close to neutral, ranging from 6.61 to 6.86, while temperature measurements were within the range of 11 to 12 degrees centigrade. Conductance measurements indicate brackish water conditions which is consistent with saline estuarine intrusion to the Snohomish River Delta area.

Seismic Conditions

The Pacific Northwest is a seismically active area, with the Puget Sound area classified as Zone 3 by NAVFAC P-355 and the Uniform Building Code. Earthquake considerations in seismically active areas include: the potential for and intensity of ground shaking; ground rupture due to faulting; and liquefaction. Ground shaking from a major earthquake could impact the site during the service life of the facility. Peak ground accelerations of 0.15 g have an approximate 80 percent probability of nonexceedence during a 50-year period. Such accelerations would likely develop from earthquakes of magnitude 6.5 or greater.

Ground rupture due to faulting is not a concern for the site. In the Puget Sound region all of the large earthquakes have been deep subcrustal events at depths ranging from 20 to 40 miles below the ground surface.

The liquefaction potential at the site is not considered significantly different than that of other saturated fills in Puget Sound. For example, the ports of Everett, Seattle, and Tacoma are all founded over areas of hydraulic dredge filling, and sandy delta deposits. Historically the Everett site has been exposed to the two major recent earthquakes of the region, Olympia 1949 and Seattle-Tacoma 1965. During both earthquakes no major damage was noted at the Everett site. The only significant Puget Sound port damage noted during those earthquakes, that we are aware of, involved movement of a bulkhead on Harbor Island, at the Port of Seattle and some ground failure at the Port of Olympia. The damage was not catastrophic, but did require repair. Seattle and Olympia are located much closer to the center of those past

earthquakes than Everett, possibly explaining why damage was not observed at Everett.

There is uncertainty associated with predicting earthquake damage in the Puget Sound region and the Everett area. This is primarily due to relatively limited data relating to major earthquakes. Analytical techniques typically predict liquefaction potential at area port facilities, while historic records (50 years) show limited damage due to liquefaction.

In the event of a major earthquake, the site could experience localized liquefaction. This could result in localized loss of foundation support, settlement, or slope distortion. Some repair of the facility might be required. It is possible that some of the contaminated sediment could be exposed by such an event.

The Elevated Upland disposal option is considered to have a greater seismic risk than the Excavated Upland disposal option. This is because in the excavation option the contaminated materials are embedded into the area land mass, having much greater confinement than the elevated option. In the event of loss of foundation support or slope distortion, it is more likely that the contaminated material would be exposed in the elevated configuration.

Smith Island Dredging and Disposal Plans

Smith Island is being considered as a disposal site for contaminated sediments dredged from East Waterway. A feasibility level study of two basic disposal configurations were evaluated. Final design of a Smith Island upland disposal alternative will require a collection of additional soil and groundwater data, geotechnical evaluation and engineering analysis. The configurations studied are identified by the positioning of the contaminated sediments above or below the groundwater elevation.

- Excavated disposal site. A cell would be excavated below existing groundwater level and subsequently backfilled with contaminated sediments. The contaminated sediments would remain saturated and anaerobic over the long term (see Figures 3-17 and 3-18).

- Elevated disposal site. Contaminated sediments would be placed above existing ground and water table within a constructed perimeter dike. Sediments may eventually dry and oxidize over the long term; therefore a disposal site liner is provided to contain potential leachate problems associated with the aerobic condition. The liner may also retard aerobic development by maintaining a perched groundwater level within the cell (see Figures 3-19 and 3-20).

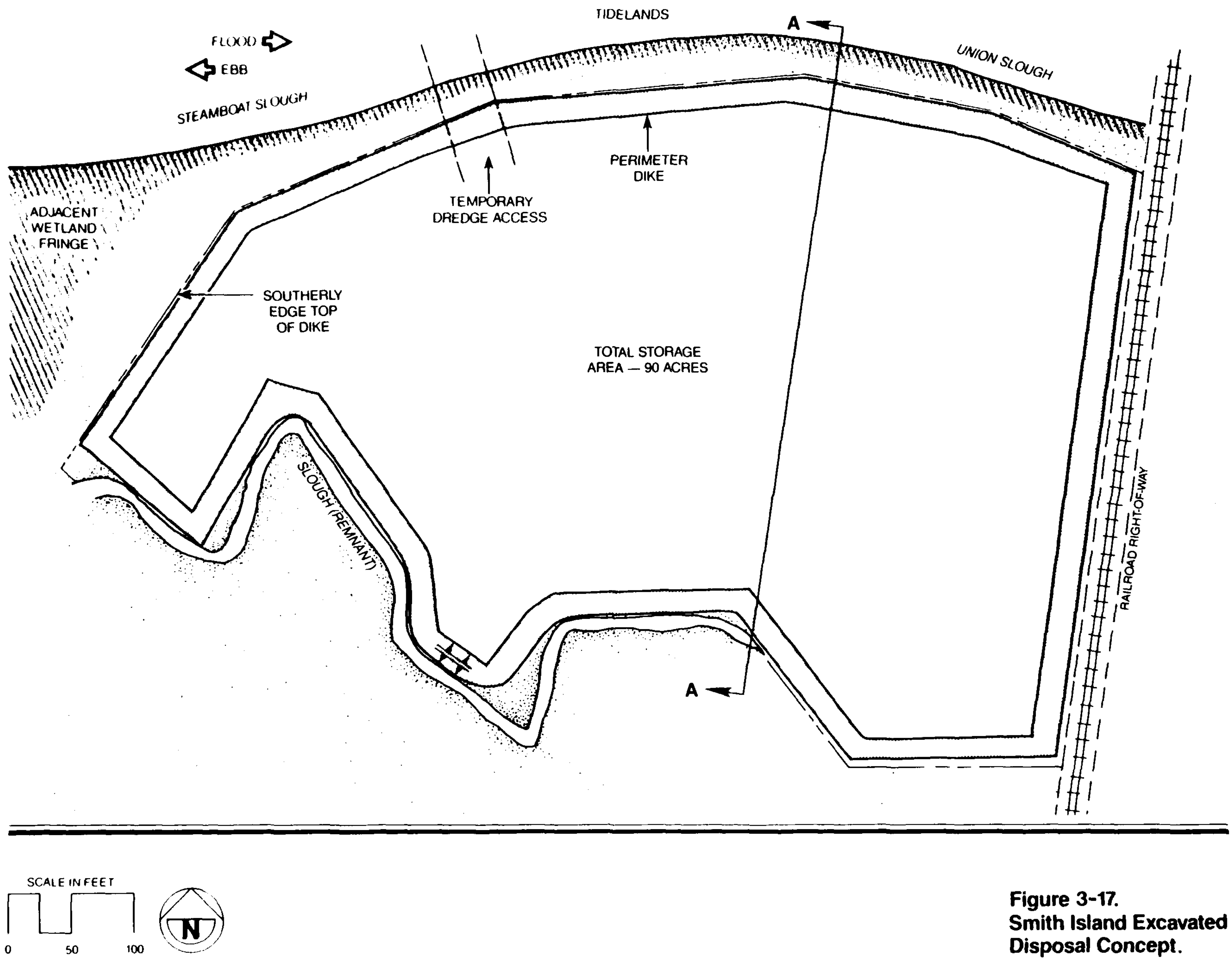
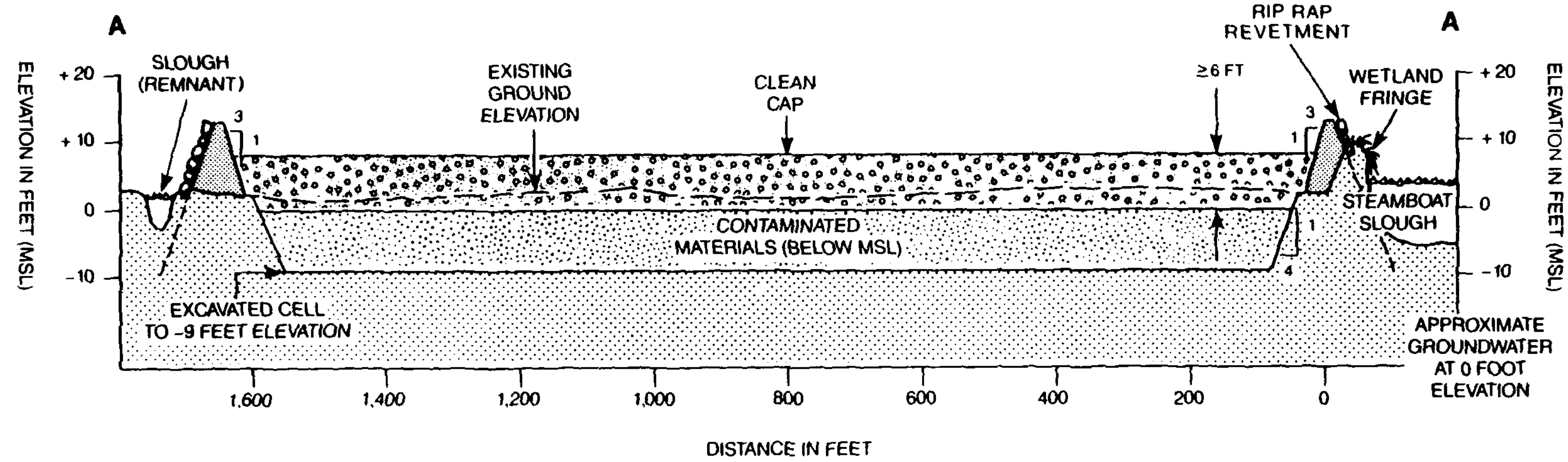


Figure 3-17.
Smith Island Excavated Disposal Concept.



Note: Elevations referenced to mean sea level (MSL)
Add 6.5 feet to MSL elevations to obtain
mean lower low water (MLLW) elevations

Figure 3-18.
Smith Island Excavated Upland Disposal Concept (Cross Section A-A).

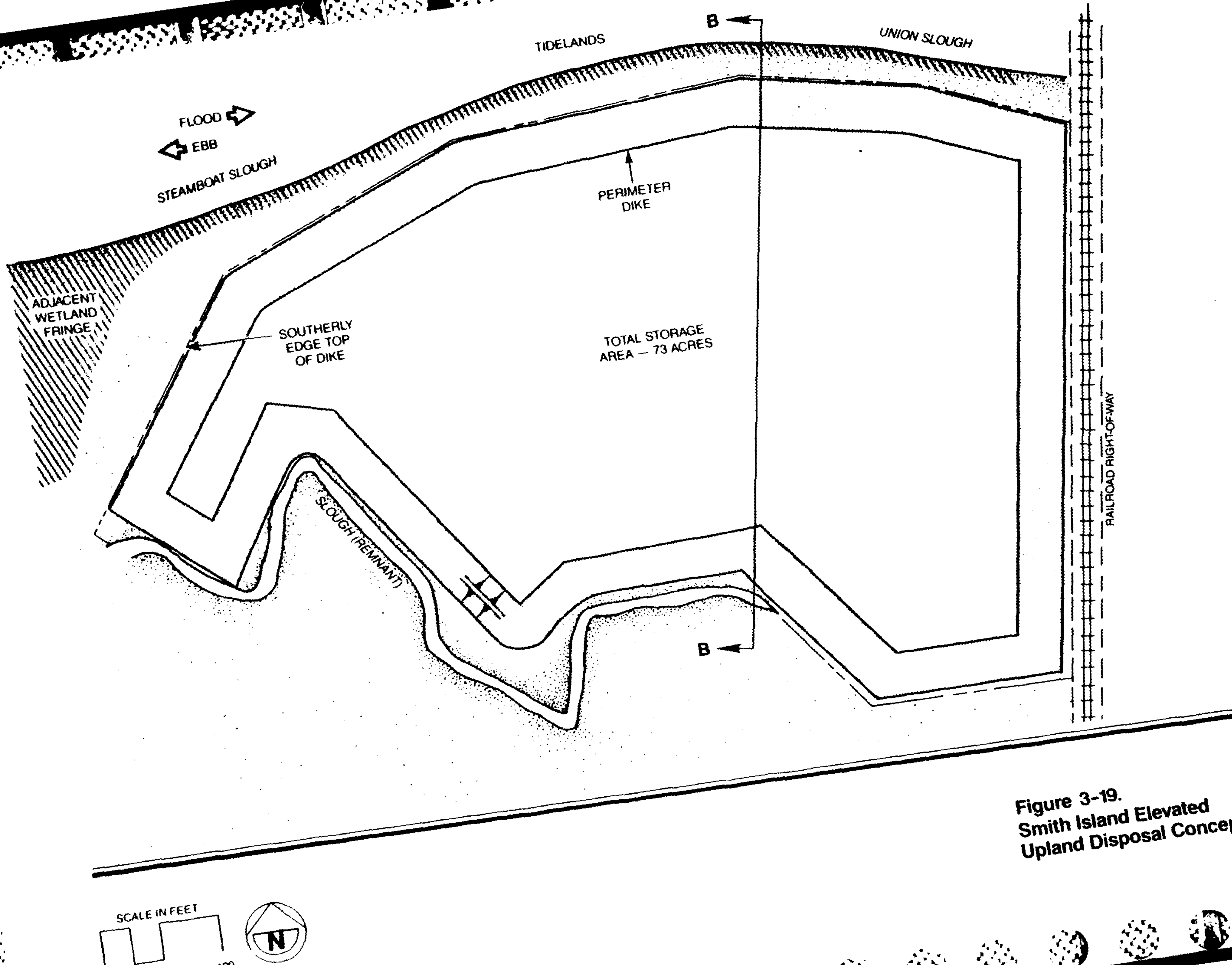
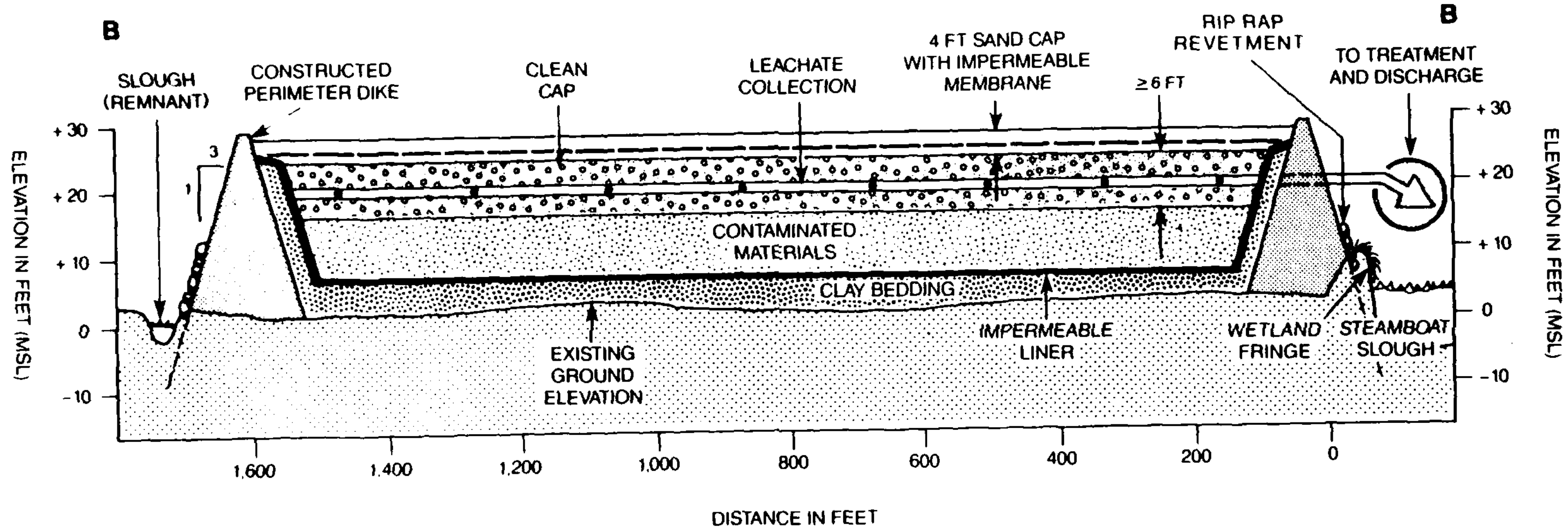


Figure 3-19.
Smith Island Elevated Upland Disposal Concept.



Note Elevations referenced to mean sea level (MSL)
MSL is approximately + 6 5 feet above mean
lower low water (MLLW) tidal datum

Figure 3-20.
Smith Island Elevated Upland Disposal Concept With Leachate Liner, Collection and Treatment (Cross Section B-B).

Both alternatives would require a containment dike structure and other extensive site preparation prior to start of the dredging and disposal operations, and a cap of clean sediments also dredged from East Waterway. Remaining clean sediments from East Waterway would be disposed to an approved deep water site in Port Gardner; this is because of Smith Island site capacity limitations and the need to provide unified confinement of contaminated sediments from both FY 87 and FY 88 dredging.

Sediment Removal

The location of the disposal site in relationship to the project area allows two dredging methods to be considered. First, the debris would be removed by mechanical dredge and barged to an offloading site for rehandling and eventual disposal at the Smith Island site. The contaminated sediments would be dredged by a hydraulic pipeline dredge and transported by pipeline discharge as a slurry to be deposited at the site. The proximity if the railroad to both the dredging and disposal areas suggest the use of this right of way for the discharge pipeline. Assuming use of rail right of way for the pipeline, approximately 25,000 feet of line would be sufficient. This pipeline length is within the capacity of modern hydraulic dredges assisted by a booster pump.

The second dredging method would be the use of clamshell and haul barges. Under this option, the barges move up Steamboat Slough at high tide and discharge into the site either by a second clamshell unloading material to trucks or by a small shore based hydraulic pumping system to pump the barge load into the disposal area. This option requires the construction of a landing for the barges in the disposal site bankline which has value as a wetland. Care in construction of access would be necessary to minimize the habitat loss.

Assuming the use of a suitable booster pump in line, production rate for a 26 inch hydraulic pipeline dredge will be 16,000 cubic yards per day for contaminated and 20,000 cubic yards per day for uncontaminated.

The pipeline alternative is a preferred option for the dredging method based on dredge production rates, estimated cost and dredging impact on the environment.

Disposal Plans

Excavated Disposal Site:

U.S. Army Corps of Engineers leachate test results (Appendix B) show that saturated anaerobic sediments generate substantially less leachate concentrations than sediments that are allowed to dry and oxidize. Placement of the contaminated sediments below

the ground water level at Smith Island has been selected to maintain the saturated condition.

The ground water level has been determined to be at approximate mean sea level elevation (+6.5 feet mllw). The existing ground surface at the disposal site averages +3 feet msl elevation. The plan for placement of the contaminated sediments is to excavate the disposal area to a depth for burial of the contaminated sediments only below the ground water level. A clean material cap would then be deposited on the contaminated sediments. The cap would be above the ground water level. A minimum six foot thick cap of clean sediments has been recommended to cover the contaminated sediments (Phillips, et. al., 1985). This cap thickness recommendation is considered necessary to prevent sediment erosion concerns and limit vegetation root contact with the contaminated sediment layer.

A low dike structure must be constructed to contain the capping sediments. To assure a settled clean cap thickness of 6 feet over the long term, the initial disposal volume pumped in by pipeline dredge must be 8 feet thick. Placement of this material above the ground water table elevation of mean sea level would require a containment dike elevation of 13 feet msl, including capacity for capping sediment, dredge pond retention time and pond freeboard. See Figure 3-18. Dike construction volume would require 160,000 cubic yards of imported sediments. The sediments for dike construction could be obtained from the existing State Department of Natural Resources (DNR) site immediately south of the proposed Smith Island site. The DNR site has been used in the recent past by the U.S. Army Corps of Engineers for disposal of maintenance dredging of the Snohomish River channel. These sediments are Snohomish River silty sands and sand materials that would be structurally suitable for the dike construction. The borrowing of the sediments would also prolong the use of the DNR site for receiving future maintenance dredging sediments from the U.S. Army Corps of Engineers. It is estimated that approximately 1,000,000 cubic yards of dredged sandy sediments are available from this site.

The dike construction would occur prior to excavation of the site for dredge disposal of contaminated sediments. This is necessary to assure access of large earth moving equipment to the site periphery over the existing ground cover. The thin layer of sediments above the water table provide limited strength for occasional passage of the equipment to the dike construction alignment. Removal of this existing ground and construction of an open ground water pit prior to dike construction would create severe access and construction limitations for the containment dike.

The sandy sediments used for dike construction will be easily eroded by surface waters during high river stages of severe flood

conditions. Revetment will be required along the dikes outer face up to an elevation of 13 feet msl. Construction of the containment dikes inside the existing low property dikes will be accomplished. Revetment will be extended up from the existing top of ground to the +13 foot elevation. This assumes the existing property dikes, bankline and fringe wetland along the slough is stable and not subject to extreme erosion as expected with the sandy containment dike sediments. Future localized erosion of the fringe wetlands may occur, requiring isolated bankline protection and repair. The containment dikes constructed along the south and east side of the Smith Island site will experience lower water velocity conditions.

After completion of the containment dike to an elevation of 13 feet msl, the remaining surface area for disposal of East Waterway dredging would be approximately 90 acres. See Figure 3-17. In this remaining area both surface sediments, typically 3 foot thick above the groundwater level, and the subsurface sediments below the ground water level down to an elevation of -9 feet msl would be excavated. These sediments would be removed and transported to an acceptable disposal site. Potential disposal sites for this excavation include the following locations (City of Everett, Department of Public Works, 1986).

- Weyerhaeuser property on Smith Island. Two parcels of open land approximately 21 and 36 acres in area.
- DNR disposal site. Presently used for disposal of U.S. Army Corps of Engineers maintenance dredging, and not considered available for non-maintenance disposal activities.
- Dagmars Landing. Open area of approximately 15 acres adjacent the existing boat storage site.
- Biringer Property. Approximately 30 acres on the east side of Union Slough.
- Weyerhaeuser Plant. Approximately 100 acres on the south bank of the Snohomish river, upstream of the Smith island site. This site does have existing structures that must be removed prior to use as a disposal site.

The Tulalip landfill site was considered for disposal of the excavated sediments. This site includes approximately 150 acres. It was determined to not be viable because of the existing requirements for acceptable filling. Those requirements included site strength that limited fill to 4 feet or less, no stock pile area availability, a cap conductivity requirement of 10x-7 centimeters per second and the entire site has been classified as

a wetland by the U.S. Army Corps of Engineers (Navy contact with Tulalip Indian Tribe, October 1986).

Another site considered was the Simpson Timber Co. disposal area approximately 4 miles upstream along the Snohomish River near the town of Lowell. This site is less feasible because of costs associated with the long pumping distance.

The surface three feet of excavated sediments from the Smith Island site that is above the ground water could be removed by earth moving equipment. This sediment could be truck hauled to the nearest sites, the Weyerhaeuser sites, for disposal. A total of 436,000 cubic yards of predominantly organic silts would be removed. This would create a fill of approximately 7.5 feet over a 36 acre area. The removal of these surface sediments would be difficult due to the limited strength of the surface layer to support the earth moving equipment. Haul roads and a specific excavation and traffic plan must be developed to complete this excavation.

Secondary impacts resulting from the disposal of this excavated material from Smith Island would occur at the selected disposal site. The impacts would be site dependent.

After the completion of the surface sediment removal, the exposed sediments would be typically at msl or ground water level. The wet conditions of the sediments would require the use of drag-line, clamshell or hydraulic dredge to remove the sediments. The locations of the potential disposal sites for this material suggest that the ability to pump this material with a pipeline dredge discharge would be more desireable than barge haul or dewatering and rehandling for overland transport to the sites. A breach in the containment dike would be made from the Steamboat Slough to allow access of the dredge and to obtain dredge slurry feed waters during the wet sediment excavation.

A total of 1,330,000 cubic yards of sediments must be excavated, including the breach from the Steamboat Slough. The disposal site for these sediments must be diked prior to receiving the sediments. The slurry condition of the sediments would mean that a 100 acre site must have a 16 foot high dike constructed prior to disposal of sediments. The eventual fill height of the sediments after settlement and dewatering would approach 8 to 9 feet for that same 100 acre area.

After completion of the dredging for disposal site pit excavation, the breach would be closed and an overflow weir would be constructed for the contaminated sediment disposal operation. A minimum time for settlement must be allowed for the breach fill prior to site use for the disposal of P-111 contaminated sediments.

The P-111 sediments would be placed into the site. Ponding depth and area would be adequate to allow a minimum retention time for the first year dredging. The FY 1988 dredging would include disposal of all contaminated sediments from the P-905 and P-112 projects plus approximately 1,253,000 cubic yards of clean sediment disposal for the cap. Based on modified elutriate testing the U.S. Army Corps of Engineers (Appendix B, DEISS) has specified retention pond requirements for various size pipeline dredges. During the final stages of contaminated sediment disposal the retention pond level will be maintained at increased depths sufficient to assure conformance to U.S. Army Corps of Engineers retention time requirements prior to overflow return to the waterway.

The remaining clean sediments to be dredged in Fy 1987 and FY 1988, approximately 739,000 cubic yards and 385,000 cubic yards respectively, would be dredged by pipeline dredge and disposed into the proposed deep water RAD CAD site or other (PSDDA) approved site. The placement of 1,124,000 cubic yards at the RAD CAD site over a two year period would cover approximately 120 acres total. Disposal would be accomplished in approximately 350 feet water depth.

Elevated Disposal Site:

U.S. Army Corps of Engineers leachate test results (Appendix C, FEISS) were characterized by increased metal losses for aerobic sediment conditions compared to the anaerobic condition. This indicated that the potential for contaminant release is higher in a confined disposal plan that allows the dredged material to become oxidized than for a plan that maintains anaerobic leaching conditions. Typically the partially oxidized sediments will constitute a relatively thin surface crust making up a small part of the total sediment mass. Even though the contaminant release from the crust may be significantly higher than from underlying materials, contaminant flux through foundation soils or through dikes probably will not be affected unless the significant portion of the containment site reaches a partially oxidized state. Placement of the contaminated sediments above the ground water level at Smith island utilizing a containment dike and a combination clay and membrane liner has been selected to assure the minimization of total site oxidization and contaminant release.

A high dike structure must be constructed to contain the contaminated sediments and a minimum cap with liner thickness of 6 feet. Total dike height required is 26 feet above existing ground, or a typical top elevation at the Smith Island site of 29 feet msl. See Figure 3-20. Dike construction volume would require 720,000 cubic yards of offsite sediments . The sediments for dike construction could be obtained from the existing DNR site that now exists immediately south of the proposed Smith

Island site. The DNR site has been used for disposal of U.S. Army Corps of Engineers maintenance dredging disposal from the Snohomish River channel. These sediments are Snohomish River silty sands and sand sediments that would be structurally suitable for dike construction if bankline erosion protection is provided. Borrow from the site would also prolong the use of the site for receiving future maintenance dredging sediments from the U.S. Army Corps of Engineers program. It is estimated that approximately 1,000,000 cubic yards of river sand sediments are available from this site.

The sandy sediments used for dike construction will be easily eroded by surface waters during high river stages of severe flood conditions. Revetment will be required along the dikes outer face up to an elevation of 13 feet msl. Construction of the containment dikes inside the existing low property dikes will be accomplished. Revetment will be extended up from the existing top of ground to the +13 foot elevation. This assumes the existing property dikes, bankline and fringe wetland along the slough is stable and not subject to extreme erosion as expected with the sandy containment dike sediments. Future localized erosion of the fringe wetlands may occur, requiring isolated bankline protection and repair. The containment dikes constructed along the south and east side of the Smith Island site will experience lower water velocity conditions.

After completion of the dike construction to an elevation of 29 feet msl, the remaining surface area for disposal of East Waterway dredging would be approximately 73 acres. See Figure 3-19. Installation of a two layer liner would then be accomplished.

The recommended liner includes two separate layers (Parametrix, 1986b). The first layer would be two feet minimum of recompacted bentonite-amended soils with a maximum hydraulic conductivity of 10x-7 centimeters per second. Site preparation would be minimal with clearing and grading of the existing ground surface level. Base soil of 250,000 cubic yards would be obtained from the remaining sediments at the DNR site. This material would be admixed with a pre-determined amount of sodium bentonite in a pug-mill and placed in four separate compacted lifts of six inches over the site.

After the soil liner is constructed, a 100 mil High Density Polyethylene (HDPE) membrane liner would be installed. The HDPE liner would be delivered to the site in pre-cut roll varying from 6 to 30 feet in width, manufacturer dependent. Seams would be joined in the field using thermal fusion techniques.

The P-111 contaminated sediments would then be pumped into the site. Ponding depth and area would be adequate to allow a minimum retention time for the first year dredging. The FY 1988

dredging would include disposal of all contaminated sediments from the P-905 and P-112 projects plus approximately 1,075,000 cubic yards of clean sediment disposal for the cap. Based on modified elutriate testing the U.S. Army Corps of Engineers (Appendix B, DEISS) has specified retention pond requirements for various size pipeline dredges. During the final stages of contaminated sediment disposal the retention pond level will be maintained at increased depths sufficient to assure conformance to U.S. Army Corps of Engineers retention time requirements prior to overflow return to the waterway.

After placement of the P-112 and P-905 contaminated sediments, total volume of 1,075,000 cubic yards of in situ clean sediments would be discharged into the site. It is assumed that this would provide a predominantly clean sediment cap of 6 feet over the contaminated after dewatering and settlement. An interface mixing of the contaminated slurry and the clean sediment slurry is probable and should be considered in any final design.
The site would then be allowed to dewater and settle for a minimum period until a shallow surface crust is formed. This time allowance will vary depending on the rainfall conditions experienced immediately after disposal operations. It is estimated that a 1 year period of natural dewatering and decanting of the site must take place along with application of the continuous trenching method to remove surface waters from natural precipitation. Following the one year dewatering of the dredged sediments, a four foot layer of dredged sands would be placed over the site, or 470,000 cubic yards of sand cap. This material may be available from the DNR site if U.S. Army Corps of Engineers dredging has occurred since removal of the existing stockpiled sediments for the dike and bottom liner construction. If sufficient volume of materials were not available at the DNR site, additional clean sediments could be stockpiled there by advance maintenance dredging of either Snohomish River Channel or East Waterway.

Prior to placement of the four foot sand cover, a leachate collection system would be installed within the surface crust of dredged sediments. The leachate collection system is intended to maintain the contaminated material cell in a saturated anaerobic condition. The collection system would include a network of six inch, perforated, plastic pipe. A filter sock around the pipe would be used to prevent the immediate clogging of the pipe by soil fines. These collection pipes would be connected to a non-perforated, collection pipe within the perimeter dike. The header pipe would converge at the northeast corner of the disposal site for further transport to constructed treatment or temporary storage facilities. The treatment facility would be designed to achieve leachate contaminant removal in compliance with waste discharge requirements and water quality standards. Preliminary evaluation identifies treatment to consist of line addition, settlement, recarboration and filtration.

The leachate collection system would then be covered with a minimum one foot of the dredged sand cover materials. A 100 mil HDPE liner would then be installed. Overlying the liner, a polyethylene drainage net and filter fabric would be installed to provide a flow path to the sides of the site for infiltrated precipitation. The final layer of the cover would be the remaining three feet of dredged sand sediments with one additional foot of organic silt materials worked into the surface of the sand fill, hydroseeded and fertilized to provide vegetation for erosion control.

The remaining clean sediments to be dredged in FY 1987 and FY 1988, approximately 739,000 cubic yards and 563,000 cubic yards respectively, would be dredged by pipeline dredge and disposed into the proposed RAD CAD site or approved PSDDA site. The placement of a total 1,302,000 cubic yards of clean material over two disposal events would cover approximately 140 acres total bottom area. Disposal would be accomplished in approximately 350 feet of water.

Impacts of the Dredging and Filling

Dredge material disposal at the proposed Smith Island site would cover an approximate 1/4 acre of wetland as defined by the U.S. Army Corps of Engineers (Appendix C). If the excavated plan is adopted for the site, an additional 1/2 acre of identified tideland between the existing dike and Steamboat Slough will be temporarily removed for dredge access and replaced at the end of the project.

The elevated disposal option will result in a double liner condition, top and bottom of the contaminated sediment placed in the site. Protection of this liner integrity will limit future use of the filled site, e.g. piling, excavated foundations, etc. must not breach the liners.

The Smith island site size prevents placement of all the dredged sediments at one disposal site. Use of a second disposal site such as a CAD site is required.

The excavated disposal option requires the utilization of approximately another 140 acres outside the Smith Island site for disposal of the excavated sediments.

Both alternatives considered for the Smith Island site will result in a diked site condition above the 13 foot msl elevation. The Smith Island site is in the developable flood fringe area for the Snohomish River. The 100 year flood elevation is 9 feet msl. Completion of either Smith Island option would require a local shoreline management permit approval. Riprap protection and

maintenance of the dike structure is necessary for long term flood protection and erosion control.

Construction Schedule

Start of dredging under the Smith Island disposal site option would be delayed until the disposal site preparation is completed. Time to complete disposal site preparation is dependent on the final dispoal alternative selected for the site. The two alternatives considered viable for site use are Smith Island Excavated and Smith Island Elevated. The construction schedule estimated for either Smith Island disposal alternative is dependent on availability of the required land.

In order to assure the long term integrity of the disposal site, it is assumed that ownership of upland disposal area be retained by a responsible public agency. Consequently, prior to construction start, the properties necessary for Smith Island Disposal option must be purchased by the ultimate long term owner and caretaker of the site. If the Navy is to be the site owner, the acquisition must be made through U.S. Department of the Navy real estate offices. Typical time required to complete real estate negotiations of this type vary depending upon the ownership questions, property zoning and other legal aspects. Based on recommendations from the Department of the Navy, a minimum lead time of up to 9 months should be allowed for property acquisition and easement procurement. This action is subject to congressional approval and it is unlikely that appropriation can be completed in time to allow for 1987 funding. Consequently, under the Navy purchase option, disposal site construction start would be delayed to 15 February, 1988, when it is anticipated that Congressional authorization and appropriation would be completed. An alternative allowing disposal construction to proceed in 1987 is possible if another public agency can acquire the parcels in a more timely manner for use by the Navy. The schedule alternatives for the excavated and elevated disposal options are reflected in Tables 3-7 and 3-8, respectively.

Smith Island Cost Estimate

Costs for dike construction, dredging and debris disposal were developed commensurate to costs provided in previous reports (ABAM, 1986). Dredging costs are based on a hydraulic dredge removing all of the sediments from the East Waterway, both contaminated and clean. Disposal of all contaminated sediments are at Smith Island. The clean sediments are disposed at both Smith Island and the proposed RAD CAD site or approved PSDDA site.

Cost estimate for the Smith Island Excavated totals $33,357,000 (see Appendix C).

Table 3-7. Construction Schedule for Smith Island Excavated Disposal Option. All contaminated sediments placed below groundwater level.

Activity	Navy Purchase Date	Non-Navy Purchase Date
Start Dike Construction	February 1988	February 1987
Complete Dike	April 1988	April 1987
Complete excavation top layer	June 1988	June 1987
Complete excavation wet sediments	August 1988	August 1987
Close dike breach	August 1988	August 1987
Complete contaminated dredging	Sept. 1988	Sept. 1987
Complete dredging	October 1988	October 1987
Start Dredging	June 15, 1989	June 15, 1988
Complete contaminated dredging	August 1989	August 1988
Complete Smith Island cap	October 1989	October 1988
Complete dredging	November 1989	November 1988

Table 3-8. Construction Schedule for Smith Island Elevated Disposal Option. All contaminated sediments placed above the groundwater level with a liner in place.

Activity	Navy Purchase Date	Non-Navy Purchase Date
Start Dike Construction	February 1988	February 1987
Complete Dike	May 1988	May 1987
Complete liner installation	August 1988	August 1987
Complete contaminated dredging	Sept. 1988	Sept. 1987
Complete dredging	October 1988	October 1987
Start Dredging	June 15, 1989	June 15, 1988
Complete contaminated dredging	August 1989	August 1988
Complete Smith Island cap	October 1989	October 1988
Complete dredging	November 1989	November 1988
Install Collection System	August 1990	August 1989
Complete surface liner/cap	November 1990	November 1989

This cost estimate includes real estate acquisition of only the Smith Island site (110 acres). The offsite areas (140 acres) for disposal of the excavated sediments to prepare the Smith Island site is assumed available on a lease with access easement basis. Alternatively, acquisition by purchase of off-site disposal areas to receive the excavated sediments could add an estimated $5,500,000 to the above cost.

In addition to the $33,357,000, costs of $500,000 for chemical flocculation of contaminated sediment dredging return flow and another $10,000,000 for dewatering the site and placing a synthetic liner may be incurred if localized long term and short term impacts are to be avoided.

Cost estimate for the Smith Island <u>Elevated</u> total $54,750,000 (see Appendix C).

This cost estimate includes acquisition of Smith Island site (110 acres) and property adjacent the site for treatment facilities (4 acres). The treatment costs reflect a five year effort. An additional cost of $500,000 for chemical flocculation of contaminated sediment dredging return flow may be incurred if localized short term impacts must be avoided.

<u>Upland Disposal Regulatory Framework</u>

Disposal of contaminated sediments to the Smith Island upland site potentially involves federal, state, and local regulatory actions related to groundwater protection and solid waste disposal. Upland disposal of contaminated dredged materials not regulated by Section 404 of the Federal Clean Water Act, may require a solid waste permit from Snohomish County Health Department unless the U.S. Navy owns the disposal site. However, the preferred disposal method is by hydraulic pipeline, runoff of which would be regulated by the U.S. Army Corps of Engineers Section 404 program, and is therefore exempted from local solid waste permit requirements.

Groundwater protection issues may require decisions by Washington Department of Ecology related to state water quality policies and rules. In addition to water quality criteria, Washington water quality regulations (Chapter 173-201-WAC) contain an antidegredation policy requiring in part that beneficial uses be protected and that all known, available and reasonable means of treatment be applied prior to discharges.

Regional authority decisions may be necessary by federal, state, and local agencies to provide federal regulatory specifics related to such issues as solid waste disposal siting, flood plain development and short and long term aspects of localized groundwater protection, surface water quality and associated mixing zones.

3.6.5. Ocean Disposal

Ocean disposal as an alternative was considered in the Navy FEIS, but was not pursued due to expected high cost and indeterminate requirements for approvable site selection and engineering design. Under provisions of the Federal Marine Protection Research and Sanctuary Act of 1972 (40 CFR, Subchapter 220) dredged material disposal to the ocean may be permitted by the U.S. Army Corps of Engineers with EPA concurrence, subject to demonstration of acceptable environmental impacts. If permittable, this disposal option would most likely involve only the "in situ contaminated" sediment, thereby limiting total volume and resulting excess costs of long distance barge transport.

There is a potential that ocean disposal of East Waterway contaminated sediments will not be approved since Section 103 requirements are more stringent than Section 404 requirements.

Under this disposal alternative, contaminated sediment would be dredged and barge-loaded for transit the same as for deep Confined Aquatic Disposal (CAD). Ocean-going tugs would move the barges through Admiralty Inlet and the Strait of Juan de Fuca to the disposal site in the Pacific Ocean. Likely near-coast disposal depths range to 100 fathoms (600 feet), near the head of Juan de Fuca Canyon, where resource values in some areas may be less than in shallow coastal and estuarine waters. The barge could be emptied as either a cohesive mass (instantaneous dump) to maximize compactness of delivery to the bottom, or by gradual release underway to maximize dilution prior to settlement. Selection of release method would depend upon resource values and available acceptable disposal area. Capping of the disposal is not contemplated. As with nearshore and upland alternatives, the clean dredged material would be disposed to an approved deep water site in Port Gardner.

Transport to a near-coast site in the Pacific Ocean involves a round trip distance of about three hundred (statute) miles from the Everett Homeport dredging site. Conventional tugs and hopper barges are available in the 4,000 cubic yard loaded category. Preliminary estimates place the cost of transport and ocean disposal of East Waterway dredged sediment within the same range of cost as for the more complex development of deep CAD in Port Gardner.

Little data is available to predict the fate or impact of dredged sediments disposed to near-coast ocean waters in the Pacific Northwest. Limited observations (Reese, 1985) indicate that dredged material disposed to the nearshore ocean environment is apparently widely dispersed by ocean processes within a year or two and generally not discernible in follow-up surveys. This implies a sediment dispersion process which would reduce

contaminant concentration to below biological effects levels with migration beyond the approved disposal site. Such ocean processes diminish both the need for capping as well as its expected long-term effectiveness.

3.6.6. Preferred Site Alternative Evaluation

The Navy FEIS identified a set of criteria for evaluation of the alternative dredge and disposal methods and disposal locations. The EISS provides the same methodology to derive a preferred alternative for dredging and disposal of the project sediments.

Criteria has been developed to evaluate disposal of uncontaminated and contaminated sediments. The same evaluation criteria used in the FEIS were applied for the EISS, and include:

- Contaminant availability
- Potential contaminant availability
- Site environmental considerations
- Erosion potential
- Institutional constraints
- Site capacity
- Relative cost
- Adequate capping materials

Each criterion was rated on a scale of 1 to 3. The rating scale was: 1) minor or no adverse effects; 2) moderate adverse effects; 3) significant adverse impacts. Minor or no adverse effects were those judged as short term adverse effects limited to resources with no special importance. Moderate adverse impacts were those judged likely to occur over an extended period of time or affect a resource of some special importance. Significant adverse effects were those judged to have a prolonged impact, particularly involving a resource of unique importance. Also included in this impact category was the lack of capacity of a particular site for all dredge materials thereby extending impacts to an additional site. The Confined Aquatic Disposal sites have been given special attention by resource agencies and others because of their relatively new and limited application. The CAD sites have been specifically designed to provide moderate environmental effects. The capping design of 1.4 meters (4.5 feet) average is to assure the sites would not have a prolonged effect or involve a resource of unique importance. The timing of the disposal for CAD sites is also important to avoid the female crabs with eggs which has been identified as a resource of unique importance. The deeper CAD sites, SW CAD and RAD CAD, also assure a criterion of moderate environmental impact is met because of the relative absence of crabs as compared to the shallower Deep Delta CAD.

Alternative sites, criteria and ratings are shown in Tables 3-9 and 3-10. Definitions of rating criteria are discussed below.

Table 3-9. Rating Matrix of Alternative Disposal Sites for Contaminated Sediments

	Contaminant Availability	Potential Contaminant Mobility	Site Environmental Considerations	Erosion Potential	Institutional Constraints	Site Capacity	Relative Cost	Monitoring Capability
Port Gardner Uncontaminated Only	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CAD Deep Delta Downpipe & Berms	1	1	3	1	2	1	2	2
CAD Deep Delta Barge & Pipe-line only	1	1	3	1	2	1	1	2
Snohomish Channel Nearshore All Sediments	1	1	3	1	2	1	2	1
Snohomish Channel Nearshore	1	1	3	1	2	1	2	1
East Waterway Nearshore	1	1	2	1	1	3	3	1
Smith Island Excavated	1	1	2	1	2	3	2	1
Smith Island Elevated	1	1	2	1	3	3	3	1
Ocean	3	1	3	1	3	1	2	3

Table 3-9. Rating Matrix of Alternative Disposal Sites for Contaminated Sediments Continued ...

	Contaminant Availability	Potential Contaminant Mobility	Site Environmental Considerations	Erosion Potential	Institutional Constraints	Site Capacity	Relative Cost	Monitoring Capability
Southwest Deep CAD Barge & Pipeline Only	1	1	3	1	2	1	2	2
Revised Application Deep CAD	1	1	2	1	2	1	2	2

1: Minor or no adverse effects
2: Moderate adverse effects
3: Significant adverse effects

Table 3-10. Rating Matrix of Alternative Disposal Sites for Clean Sediments

	Site Environmental Considerations	Availability for Capping	Institutional Constraints	Site Capacity	Relative Cost
Port Gardner Uncontaminated Only	2	2	3	1	1
CAD Deep Delta Downpipe & Berms	3	1	1	1	2
CAD Deep Delta Barge & Pipe-line Only	3	1	1	1	1
Snohomish Channel Nearshore All Sediments	3	1	1	1	2
Snohomish Channel Nearshore	3	1	1	2	2
East Waterway Nearshore	2	1	1	3	3
Smith Island Upland Excavated	1	1	2	2	2
Smith Island Upland Elevated	1	1	3	2	3

Table 3-10. Rating Matrix of Alternative Disposal Sites for Clean Sediments (cont.)
Continued ...

	Site Environmental Considerations	Availability for Capping	Institutional Constraints	Site Capacity	Relative Cost
Southwest Deep CAD Barge & Pipeline Only	3	1	1	1	2
Revised Application Deep CAD	2	1	1	1	2

1: Minor or no adverse effects
2: Moderate adverse effects
3: Significant adverse effects

1 Contaminated Sediments

Contaminant Availability. Availability of contaminated sediment in the disposal site to come in contact with marine benthic organisms through physical contact or ingestion via the aquatic food web.

Potential Contaminant Mobility. Potential for contaminants in the sediments moving from the disposal site or being dispersed into the water column during or after dredge spoil placement.

Site Environmental Considerations. Environmental impacts which may occur on fauna presently utilizing the disposal area and consideration to unique critical habitats such as wetlands, an isolated reef, etc., which occur in only one place or have limited distribution over the study area.

Erosion Potential. Potential for contaminants eroding from disposal site due to man or natural causes.

Institutional Constraints. Constraints and/or regulations of governing agencies which affect the operation of the project. These could include constraints on both dredging and filling operations.

Site Capacity. Capability of the site being evaluated to hold the estimated amount of material to be dredged.

Relative Cost. Estimated cost for deposition of dredged material at the site being evaluated as compared to other alternative sites (Table 3-7).

2 Clean Sediments

The criteria definitions for Site Environmental Considerations, Institutional Constraints, Site Capacity, and Relative Costs, are the same as for the Contaminated Sediments. Availability for capping criteria is the availability of the site being evaluated for using clean dredged sediments as capping material for contaminated sediments placed on the site.

The ratings shown are qualitative and display estimated relative weights for a given criteria between alternate sites. Also, relative weights are not presumed equal for different criteria. Consequently, Tables 3-9 and 3-10 do not present numerical sums as a basis for final selection of the preferred disposal alternative, but provide a framework within which final selection is made. Other important factors considered in final selection of the preferred disposal alternative include constructability, reliability/risk and monitoring.

3.7 Impact of Debris, Silt and Contaminants Transported to Residential Shorelines

Debris is classified as the top layer of decaying logs, rope, metals, tires, piping, cables and other miscellaneous materials lying on the top 0 to 4 feet of the existing harbor bottom. The dredging plan calls for the removal of the debris layer by an orange peel, rake or modified clamshell bucket. The debris removed from the harbor will be disposed of in an approved upland disposal site. Therefore, there will be no transport or impact of these materials on beaches in or near Port Gardner resulting from disposal of the dredged debris layer.

The dredging plan calls for dredging of all contaminated sediments with a clamshell dredge. There will be a relatively minor increase in suspension of the uncontaminated silts due to the use of a hydraulic dredge on these clean sediments than would have occurred if they were dredged and disposed by clamshell and bottom dump barge (see section 3.4.3.). The suspended solids concentration and turbidity will increase in the water column during and immediately following the disposal operation. Current studies by Northern Technical Services (1986b) and the circulation modeling presented in the FEIS indicate that the plume will be transported away from the discharge point predominant.y in a northwesterly direction. The currents at the CAD site are very low, thus it will take several tide cycles to disperse the turbidity plume beyond the site limits after a dump of the contaminated sediments. A majority of the turbidity plume is predicted to settle out in the immediate disposal area.

The silts released to the water column during the disposal operation will have no significant impact on residential beaches because of the negative buoyancy of the silts, the slow transport away from the CAD site, and the wave action at beaches. The Whidbey Basin/ Possession Sound already has a high input of silts from the major rivers in the region, and demonstrates that these sediments settle out in the deeper regions of the basin with the lowest current speeds In addition, the loading of silts from these sources is far greater than the release during temporary dredge disposal operations. The stronger surface currents and waves at the water surface prevent silts from depositing on rocky or sandy beaches. Therefore, no siltation of nearby sand and gravel beaches is anticipated to result from the dredge disposal operations.

The contaminated sediments in the harbor will be dredged with a clamshell dredge which tends to maintain the sediments in a clump during deepwater disposal, thereby minimizing the release of pollutants to the water column. The contaminated materials will be capped with clean sediments to prevent the steady release of contaminants after the disposal operation is completed. However, the disposal operation will result in the release of some

contaminants to the water column, as discussed in the section on water quality impacts. Those pollutants with negative buoyancy will settle in the deep, quiescent pockets of the basin with the silts. Of the neutrally buoyant pollutants, some will be adsorbed onto the negatively buoyant silts that will be present in high concentration during disposal.

Neutrally buoyant pollutants not readily adsorbed onto silts will be transported and assimilated into the ambient water by currents in the basin. As stated previously, currents and flushing at the disposal site are weak, thus transport away from the site will initially be slow. However, when the pollutants are carried out into the stronger tidal currents near Gedney Island by the net northwesterly currents at the CAD site, the transport is accelerated. Although a transport model has not been conducted for the CAD site, the stronger currents in the central tidal channels (see Appendix X in the Navy FEIS) suggest that pollutants could be transported to residential beaches on Whidbey Island within one or two tide cycles. Based on the methods of Brooks (1960), which predict dilution of a neutrally buoyant plume as a function of travel time and initial plume dimensions, the dispersion of the pollutants by ambient currents would dilute the plume by a minimum factor of 30 or more within one tidal cycle (i.e., 12.4 hours).

The probability of contact of the pollutant plume at measurable concentrations is very low for the residential beaches in the area. The volume of contaminated water associated with the dredge material plume is very small in comparison with the tidal flow past these beaches, and the pollutants will tend to remain submerged in the water column, below near-surface density stratification associated with the shallow freshwater layer in the Whidbey Basin.

Open water disposal may release some positively buoyant pollutants to the water column. The occurrence and impact of this floatable fraction is being considered by the Puget Sound Dredged Disposal Analysis (PSDDA) and Puget Sound Estuary Program (PSEP) with plans for detailed investigations scheduled to begin in FY 1988. It is premature to make conclusions here on the impact of these materials at the water surface. However, the fate of the materials can be reasonably projected. EPA states (comments on draft of this EISS, Sept. 2, 1986) that East Waterway sediment contamination exceeds preliminary agency consensus levels of concern relative to positively buoyant materials.

Studies have shown that the floatable materials have a high affinity for the shorelines. Any floatables that contact the shoreline are likely to be deposited on that shoreline. Therefore, the transport and deposition of these materials is very similar to that of spilled oil. A model of the fate of spilled oil was conducted and presented in the Navy FEIS (Appendix Y).

The model showed that, because of the predominant wind directions and tidal dynamics, those shorelines at greatest risk are located within a half-mile radius of the harbor, for a source near the mouth of the Snohomish River. The Snohomish River intertidal shoreline and the delta were also shown to be susceptible to the transport and deposition of floatable contaminants. The probability of transport to residential sand, gravel or cobble beaches was shown to be small, particularly for Whidbey Island.

4. WATER QUALITY ANALYSIS

Please refer to the Navy FEIS for a discussion of the impacts to the environment concerning Water Quality. The following additional material has been developed as a result of comments made during the U.S. Army Corps of Engineers' scoping process for the DEISS and/or from new information resulting from investigations completed since release of the Navy's FEIS.

4.1 Dredging Impacts

4.1.1 Sediment Chemical Characterization

In June 1985, contaminated sediment samples were collected from 16 stations inside East Waterway and combined to form 8 cubic yards of composited sample which was provided to the Waterways Experiment Station (WES) for physicochemical testing. One cubic yard of native sediment was also collected for testing. Subsamples of the composite and native sediments were provided to the Battelle-Pacific Northwest Laboratory (PNL) for separate chemical and biological testing. This split sample testing was conducted to maintain the cortinuity of analyses between Phases I, II and III by having the same laboratory perform the same analyses for each phase of sediment testing. Results of the Phase III analyses by PNL were reported by Crecelius and Anderson (1986). Comparison of PNL chemical results for the composited sediment with the range of chemical values from individual cores previously analyzed (Anderson and Crecelius, 1985) indicated that the composite sediment was representative of the more, though not the most, contaminated sediments previously encountered in East Waterway. Separate chemical analyses on the composited sediment were performed by WES to establish a reference for the extensive mobility tests to be performed and to develop a select list of specific compounds that would be tracked during testing. Sediments were stored at 4 degrees C until used. No frozen sediment was used for any testing by PNL or WES. Because different analytical techniques were used by PNL and WES, the chemical values derived are not directly comparable.

Priority pollutant analysis of the composite sediment sample, collected in the East Waterway by the U.S. Army Corps of Engineers (Appendix D of the DEISS), indicated the presence of 33 sediment contaminants of concern. These compounds included the following; chromium (Cr), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), lead (Pb), cadmium (Cd), mercury (Hg), polychlorinated biphenols (PCBs), polynuclear aromatic hydrocarbons (PAHs), and 1- and 2-methylnapthalene. These identified compounds may potentially impact water quality during dredge and disposal activities involving these sediments. In this regard, water quality criteria have been established by the USEPA for most of these contaminants. Thus, the release of any of these contami-

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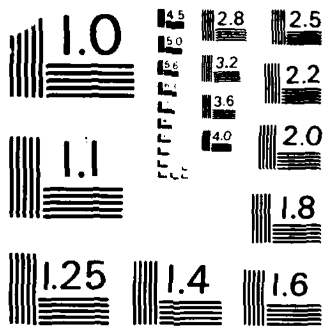

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nants into the water column from dredging activities may pose a water quality concern if the water quality criteria are exceeded.

4.1.2 Sediment Resuspension and Contaminant Release During Dredging

The rate of sediment re-suspension during dredging activities has not been extensively studied (Appendix D of the DEISS). For conventional clamshell dredging, approximately two percent of the total volume of dredged material is reportedly resuspended or overflowed from the barge at the point of dredging with 1.2 percent of the total due to actual dredging and 0.8 percent resulting from barge overflow (Tavolaro, 1984). Resuspension of sediments resulting from the use of cutterhead dredges is reported to be generally less (a total of 1.0 percent) than the 2.0 percent total noted for clamshell dredge operations (Hayes, 1985; Appendix D of the DEISS).

Resuspended sediment contaminants that subsequently reach the sea surface microlayer (SSM) may pose a threat for the biotic community present there. Recent investigations into the contamination of the SSM, as a result of dredging activities, have provided no direct or conclusive evidence regarding the contribution of dredging and/or disposal (Word et al., 1986; Hardy and Cowan, 1986).

During dredging resuspended sediment material may release contaminants to the water column. Release of contaminants, and therefore impacts resulting from the disturbance of these sediments, may be expected to follow the same pattern as that described in the following discussion of contaminant release during open water placement of dredge materials.

Information on impacts to biota from dredging and disposal are discussed in Chapter IV of the FEIS, pages 49-52 and 96-104.

4.2 Dredge Disposal Impacts

4.2.1 Confined Aquatic Disposal - Deep Delta

Standard elutriate tests were conducted by the U.S. Army Corps of Engineers on the previously noted composite sample of sediments collected from the East Waterway (Appendix D of the DEISS). This information was then used to estimate the potential for dissolved contaminant release to the water column during open water placement of dredge materials (CAD alternative). Elutriate testing indicated that only 7 of 33 contaminants of concern were detected in the elutriate water, i.e., copper (Cu), mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr), nickel (Ni), and PCB-1254. Of these, only the latter 5 exceeded Port Gardner background levels (Table 4-1). Based on dissolved concentrations

Table 4-1. Summary of Dissolved Concentrations for Standard Elutriate Tests and Criteria (Source; Palermo et al. 1986)

Parameter	Dissolved Concentration ppm	Site Water Concentration ppm	Federal WQ Criteria ppm chronic	Federal WQ Criteria ppm acute	Remarks
Copper	.007	.007	.004	.023	Test < background
Nickel	.015	.007	.007	.140	Test < acute background
Cadmium	.003	.0006	.0045	.059	Test < chronic background
Lead	.028	<.001	.025	.668	Test > background
Chromium	.008	.004	.018	1.2	Test < chronic background
Mercury	.0066	.0067	.000025	.0037	Test < background
PCB-1254	.0004	<.0002	.00003	.00003	Dilution factor = 13

nickel, lead, and PCB-1254 exceeded US EPA water quality criteria.

The standard elutriate procedure was modified to obtain analyses of total contaminant concentrations associated with mass release to the water column of Puget Sound during dredging and open-water disposal (CAD) of East Waterway sediments. Results of these tests (U.S. Army Corps of Engineers, 1986a) revealed that concentrations of total Ni and Pb only slightly exceeded the measured dissolved concentrations of these metals (i.e., 15 ug/l dissolved versus 17 ug/l total for Ni and 28 ug/l dissolved versus 30 ug/l total for Pb). Thus undiluted, the effluent concentration of these two metals would exceed the US EPA water quality criteria. The dilution factor required to meet water quality criteria would be approximately 3 for Ni and one for Pb.

The total concentration of PCB 1254 was observed to be less than the dissolved concentration (i.e., 0.3 versus 0.4 ug/l, respectively). The dilution factor necessary to achieve compliance with water quality criteria for the higher dissolved value is approximately 13.

Based on these tests, potential water quality impacts during open water placement of contaminated sediments (CAD site) appear to be limited to these three pollutants. In this regard, the concentration of Ni in the elutriate was shown to exceed chronic criteria, but was well below the acute exposure value. Because Port Gardner waters sampled by the U.S. Army Corps of Engineers and identified as background or reference waters (Appendix D of the DEISS) equal the chronic criteria value for nickel, dilution of the elutriate with this water would not reduce the elutriate concentration below the chronic level. In the case of Pb a dilution factor of one would result in water concentrations below the chronic criteria concentration for the elutriate. For PCB-1254 a dilution factor of approximately 13 would be necessary to reduce the elutriate concentration to below the chronic exposure level. It should be noted that other water samples collected from the East Waterway have exhibited much lower levels of Pb and other contaminants of concern (see Appendix J of the Navy's Final EIS).

Dilution at the site of dredging or disposal is a specific function of the size and configuration of the mixing zone. While such specific information is not yet available, it appears that a dilution factor of 13 or greater would be readily attainable within a short distance of the dredge or disposal operation. Consequently, water column concentrations of Pb and PCB-1254 would be expected to be below the criteria established for the protection of marine aquatic life. The concentration of Ni would continue to be at background levels which are within the chronic toxicity range.

The mass sediment release of contaminants or suspended sediment remaining in the water column was estimated to be 2.0 percent during dredging and 2.0 to 2.1 percent during open water disposal (CAD alternative), respectively. These estimates of mass release were based upon the loss of solids plus an estimate of the dissolved contaminant release measured in the elutriate testing (U.S. Army Corps of Engineers, 1986a) and upon recent information regarding currents in the area of the proposed CAD sites (NORTEC, 1986). Mass release of contaminants to the water column during disposal through a vertical pipe, was said to be negligible except for Cd (0.1 percent release) and Hg (0.2 percent release).

Based on estimates of contaminant release and on the adequate dilution of such contaminants, the impacts to water quality and related biota of East Waterway and Port Gardner appear to be relatively minor. Bioaccumulation will occur within the local biota. However, the capacity for environmental accumulation, persistence, and effects of specific toxicants is reflected in water quality criteria applied to the analysis presented herein. As long as water quality criteria are met within the applied mixing zone for sediment disposal or ancillary discharges, adverse affects from bioconcentration of contaminants of concern will be minimal. Because no quality criteria exist for sediments, it is not possible to evaluate the upper concentration limit of any given sediment pollutant that will protect the associated biota against contaminant effects. However, maintenance of low pollutant levels (i.e., below water quality criteria) in the overlying water column would appear to provide a high degree of sediment biota protection. The relatively short-term nature of dredging and disposal activities will also ensure that the bioaccumulation of contaminants is minimized.

The increase in turbidity from dredge and disposal activities could in the short term extend over a relatively large area and would be very evident to observers. This turbidity will result in reduced sunlight penetration and will likewise reduce primary production. Such reduction will be intermittent short-term, and involve only a relatively small area. Significant suspended particle movement outside of the dredging and/or disposal area is not anticipated. Therefore, physical covering or smothering of benthic organisms outside these areas is not expected to be a problem.

Maintenance dredging is anticipated to occur as a result of normal operations at the proposed facility. Such future activities will require an assessment of environmental impacts as part of the permitting process necessary for those activities and are therefore not addressed herein.

4.2.2 Upland or Intertidal Disposal

Modified elutriate tests were conducted by the U.S. Army Corps of Engineers in order to estimate contaminant concentrations in effluent discharged from dredge disposal sites located in intertidal or upland areas (Appendix D of the DEISS). These tests were designed to estimate dissolved and particulate-associated contaminant concentrations in the effluent generated during the placement of hydraulically dredged sediments. The modified elutriate test results indicated that dissolved concentrations of Ni and PCB-1254 exceeded background water quality conditions in Port Gardner (Table 4-2). Nickel exceeded the chronic exposure level but was below the acute criterion. Because background water quality levels of Ni presently exceed the chronic criterion, dilution of the elutriate with this water would not reduce the observed level below the chronic level. In the case of PCB-1254, dilution of the elutriate by a factor of approximately 13 would reduce the concentration present to below the chronic criteria level. Such dilutions appear to be easily achieved at only a short distance from the point of discharge of the effluent generated from hydraulic dredge spoils.

The above analysis assumes that runoff from hydraulically dredged sediments will enter the saline waters of East Waterway or Port Gardner. However, if such runoff enters the fresh waters of the Snohomish River then criteria for freshwater will apply. In the case of Ni, the freshwater criteria (i.e., 0.56 ppm for chronic exposure and 1.10 ppm for acute exposure) are less stringent than for saline water. Thus, Ni will not pose a water quality problem for such a discharge. For dissolved PCBs the freshwater criteria (i.e., 0.014 ppm for chronic and acute exposure) will be exceeded by the dredge effluent waters unless a dilution factor of 29 or greater is achieved. Obtaining such a dilution may require a diffuser system for the discharge line.

The modified elutriate test procedure also examined the mass release of sediment contaminants for evaluation of total contaminant concentrations for effluent discharged from a confined disposal site (U.S. Army Corps of Engineers, 1986). The concentration of chromium (Cr) and PCB 1254 were observed to exceed the dissolved concentrations (Table 4-3). PCB 1254 would continue to exceed the US EPA saltwater quality criterion and would require a dilution factor of >20 to meet the criterion assuming such effluent was discharged to saltwater. If discharged to freshwater (i.e., the Snohomish River) the criteria for Cd, Cr, and PCB 1254 would be exceeded. Dilution factors of 17, 28, and 43 respectively, would be necessary to reduce the total concentration of these contaminants to below the acceptable water quality criteria.

Based on the above described elutriate test results and upon the attainment of adequate receiving water dilution, the impacts to Port Gardner water quality and biota from the contaminants of concern appear to be minimal.

Table 4-2. Summary of Dissolved Concentrations for Modified Elutriate Tests and Criteria (Source; Palermo et al., 1986)

Parameter	Dissolved Concentration ppm	Site Water Concentration ppm	Federal WQ Criteria ppm chronic	Federal WQ Criteria ppm acute	Remarks
Copper	.006	.007	.004	.023	Test < background
Nickel	.018	.007	.007	.140	Test < acute criteria
Cadmium	.0002	.0006	.0045	.059	Test < background
Chromium	.003	.004	.018	1.2	Test < background
PCB-1254	.0004	<.0002	.00003	.00003	Dilution factor = 13

Table 4-3. Summary of Total Concentration and Mass Release for Modified Elutriate Tests, Snohomish Channel (100 Acres)

Mass Release Parameter	Bulk Sediment mg/kg	Inflow[1] mg/l	Dissolved Modified Elutriate mg/l	Total[2] Modified Elutriate mg/l	Effluent[3] Concentration mg/l	%
Copper 0.05	73.4	11.01	0.006	0.003	0.006	
Nickel	21.4	3.21	0.018	0.017	0.018	0.6
Cadmium 0.04	3.3	0.50	0.0002	0.0002	0.0002	
Chromium 0.59	39.7	5.96	0.003	0.008	0.035	
PCB-1254	0.25	0.0375	0.0004	0.0006	0.0017	4.5

1 Based on an inflow concentration of 150 g/l.

2 Samples containing a mean suspended solids concentration of 29 mg/l.

3 Based on settling analysis for a 100 acre site, 26" dredge, resulting in effluent suspended solids concentration of 185 mg/l.

4.2.2.1 Surface Runoff Impacts

Tests were conducted by the U.S. Army Corps of Engineers to estimate the potential impacts to receiving water quality as a result of surface water runoff from a confined upland or near-shore dredge disposal site (U.S. Army Corps of Engineers, 1986). A rainfall simulatory-lysimeter was utilized to predict the quality of surface water runoff from such a disposal site.

Surface runoff tests conducted on sediments from East Waterway during the wet anaerobic stage indicate that the primary water quality impacts will result from high suspended solids concentrations (Appendix D of the DEISS). Sediment contaminants remained tightly bound to these sediments and filtered runoff concentrations of contaminants of concern were observed to be below US EPA maximum criteria for the protection of aquatic life (Table 4-4). The control of total suspended solids during confined upland or nearshore dredge disposal will be necessary to provide maximum protection to the receiving water. Impacts related to high suspended solids loading include: increased turbidity to the receiving waters, light reduction, and covering of benthic biota due to settling particulate matter. Slight reductions in dissolved oxygen concentrations may also occur in the water column due to the presence of reduced compounds (i.e., H_2S, HS^-, FeS, NH_4^+, etc.) and organic matter.

Table 4-4. Contaminant Loads in Surface Runoff from Wet, Oxidized Sediment During a 5 cm/hr, 30 min. Storm Event, (Runoff Volume = 187 liters). Source; Appendix D of the DEISS)

Parameter	Filt. Conc. (mg/l)	Load (mg)	Load (mg/Ha)	EPA Maximum Criteria (mg/l) (US EPA 1981)
PAH	0.0004	0.075	134	N
Cd	0.0002	0.037	67.1	0.0015-0.0063
Cu	0.005	0.935	1677	0.012 -0.043
Pb	0.004	0.748	1342	0.074 -0.400
SS	6900	1.29kg	2315 kg/Ha	N

N: No Values Available

If dredged sediments placed in upland or nearshore sites are not capped and are allowed to dry, physicochemical changes will occur. Under such conditions, runoff water from rainfall would potentially carry dissolved contaminants from the site. Studies conducted with East Waterway sediments indicate that under these conditions the concentration of dissolved Cd would substantially exceed US EPA water quality criteria (Appendix D of the DEISS). However, capping of these sediments would occur and thus no such adverse impacts are anticipated.

4.2.2.2 Leachate Testing

The potential for generation of leachate from an upland disposal site was studied using experimental laboratory testing procedures for sediments collected from the East Waterway (U.S. Army Corps of Engineers, 1986a). Leachate contaminant levels from these sediments were quantified using batch and column testing techniques.

Based on these leachate tests, the geochemical changes associated with aerobic disposal on land would result in mobilization of a large fraction of some of the contaminants. If the material could be placed below the water table at a given site (usually more of an option for nearshore/intertidal disposal), such mobilization would be significantly reduced. The leaching tests indicated that mobility of metals and organic contaminants is low under anaerobic conditions. Under aerobic conditions, some of the metals were mobilized in large quantities. The fraction of metals that was resistant to anaerobic leaching was generally greater than 90 percent of the bulk sediment concentration. Under aerobic conditions, over 85, 65, and 49 percent of the Zn, Ni and Cd respectively was mobilized in the tests. The higher metal release observed in aerobic testing is related to the pH i.e., the pH in aerobic testing was lower than the pH in anaerobic testing.

Table 4-5 indicates that Cr and Pb predicted in leachate from the anaerobic disposal environment would slightly exceed drinking water standards. In aerobic disposal environments, Cd, Cr and Pb would exceed standards by a substantial amount. Though the application of drinking water standards as criteria for the design of an upland site may not be appropriate for sites not in proximity to potable groundwater, these data clearly suggest that potential leachate losses would need to be addressed for the upland disposal option.

Table 4-5. Results of leaching studies conducted on contaminated East Waterway sediments (U.S. Army Corps of Engineers, 1986b). Concentrations of various contaminants are presented in mg/L.

Contaminant	Anaerobic	Aerobic	Federal/State Drinking Water Standards
As	.039	0.005	0.05
Cd	.010	0.034	0.010
Cr	.080	2.27	0.05
Cu	.096	0.023	1.0

Table 4-5 (Continued)

Contaminant	Anaerobic	Aerobic	Federal/State Drinking Water Standards
Ni	.052	0.449	NA
Pb	.058	0.210	0.05
Zn	.181	3.5	5.0
PCB	.00036	0.00176	NA

NA: Not available.

4.3 Graywater Impacts

4.3.1 Proposed Action

Graywater consists of waste waters originating from showers and sinks, laundry areas, and food preparation areas. The primary constituents include handsoaps, shampoo, laundry detergents, fabric softeners, laundry bleach, dishwashing soap, and food wastes. Graywater does not normally include human or industrial wastes. Absolute exclusion of these constituents is not possible and residual amounts may enter this system periodically.

Eleven of the ships that would be homeported at the Everett Homeport have the capability to collect graywater internally, as would the visiting destroyer tender (AD). These ships have provisions enabling them to hook-up to the onshore sewerage system and subsequently discharge to the Everett municipal sewage treatment facilities. However, graywater would be discharged during periods of high operational tempo. The term "high operational tempo" refers to the status of a ship that is entering or leaving the port. This time sequence would involve about one hour in East Waterway although it could extend to as long as three hours. For ships, this period of time is char-

acterized as being particularly vulnerable and therefore must be completed quickly. Priority is placed on activities to achieve this end (e.g. communications hookup, rapid docking, rapid deployment, etc.). While graywater may be diverted into blackwater holding tanks during this time, personnel may or may not be readily available to operate the numerous valves and controls necessary for such diversion. Such graywater discharge could continue during passage through Possession Sound and Puget Sound as well. While leaving port, operational necessity dictates that ships discharge graywater in order to save holding capacity for blackwater (i.e., sewage) to insure that none of the latter is discharged. Blackwater cannot be discharged within 3 miles of land. Therefore, when arriving in port, holding tank capacity steadily decreases. Priority must be given to holding blackwater as its discharge would be more objectionable from a public health standpoint. As an result, graywater must be discharged. However, the possibility exists that travel time to and from the Straits of Juan de Fuca may be short enough to allow for the diversion and collection of graywater in the holding tanks otherwise designated for blackwater. To the extent possible all efforts will be made to collect graywater in holding tanks while in transit within Puget Sound, Possession Sound and East Waterway. Limitations of such collection include blackwater holding tank capacity and operational time needed to activate diversion systems.

The remaining four ships (two DD and two DDG vessels) do not currently have the internal collection systems necessary to discharge graywater to shore facilities. In a conservative situation, graywater from those vessels would be discharged directly overboard. However, the Navy's recently completed draft feasibility study indicates that modifying these vessels with internal graywater collection systems is feasible. If the DD and DDG vessels are retrofitted, graywater discharges will only occur as ships enter or leave port.

4.3.2 Characteristics of Proposed Discharge

The 11 ships (plus visiting tender) equipped with graywater collection plumbing could as stated previously, discharge graywater while entering and leaving port. Based on the entrance/exit scenario shown in Table IV-31 in the FEIS, the volume of graywater from each class of ship during arrival and departure has been summarized in Table 4-6. Using a time of three hours for any given ship to pass through the East Waterway, approximately 19,167 gallons could be discharged on 10 different occasions, 1,164 gallons on 24 occasions, and 4,356 gallons on 8 occasions per year. The three temporal groupings are considered independent of each other. These estimates are conservative, i.e., actual periods of discharge during port exit and entry are anticipated to be approximately 1/3 of those projected for this analysis.

Table 4-6. Estimated volume of graywater discharged during departure and arrival of fleet vessels for the proposed Everett Homeport.

Ship Class	Number in Carrier Group	Number of Arrivals & Departures per Year per Ship	Flow Gal/Day[1]	Flow for 3-Hr. Period	Total Discharge per Ship per Year (Gallons)
CVN	1	10	64,698	8,087	80,870
CG	2	10	6,881	860	8,600
CGN	2	10	21,819	2,727	27,270
DD	2	10	5,688	711	7,110
DDG	2	10	6,455	807	8,070
FFG	2	10	3,478	435	4,350
FFG	2	24	3,478	435	10,440
MCM	2	24	1,177	147	3,528
AD	1	8	34,844	4,356	34,848

Total greywater discharge per year[2] = 185,086 gal.

1 DTNSRDC ltr 2834:MMB 9593 2834-507 of 13 Sept. 1984.
2 Includes only discharge made while entering and leaving Port.

The greatest volume of graywater discharge would potentially come from the two DD and two DDG class vessels while in port. The estimated rate of discharge is 5,688 and 6,455 gal/day respectively for the two vessel types. The total discharge for the four vessels would be 24,286 gal/day. Water quality information for graywater discharges by DD class vessels is summarized in Table 4-7. It may be assumed that graywater discharges from the other vessels would be of similar composition. Using the Tidal Prism method (TPM) of estimating dilution rates (see organotin discussion) for discharges, ambient concentrations of heavy metals and surfactants (methylene blue active substances; MBAS) were calculated (Table 4-8). Because of the buoyant nature of this low salinity discharge, the analysis assumes that the graywater dilution zone is restricted to the upper 2 feet of the East Waterway. Estimates are conservative in view of the fact that the assumption is made that no circulation exists other than that due to tidal currents. In fact, the buoyant freshwater discharge of the Scott Pulp and Paper Mill would tend to entrain the graywater and carry it out of the East Waterway more rapidly than first order tidal flushing would indicate. Based on the assumptions listed in the TPM description (organotin section), all

Table 4-7. Graywater in port mass emission data for a DD class Vessel.

Parameter	Head Areas (LB/D)	Food Areas (LB/D)	Laundry (LB/D)	Total (LB/D)	Total (ppm)
Total Suspended Solids	3.78	2.81	0.52	7.11	150
Total Solids	8.25	13.7	6.83	28.78	606
Total Volatile Solids	2.91	11.1	2.36	16.37	345
Total Dissolved Solids	5.01	8.48	6.05	19.54	412
Biochemical Oxygen Demand	3.27	7.07	0.67	11.01	232
Chemical Oxygen Demand	7.07	18.2	2.82	28.09	592
Total Organic Carbon	1.41	2.67	0.55	4.63	10
Oil & Grease	1.26	0.52	0.15	1.93	41
Ammonia Nitrogen	BDL	1.988E-03	BDL	1.988E-03	0.04
Nitrate Nitrogen	5.788E-03	1.624E-03	4.753E-03	1.217E-02	0.26
Nitrite Nitrogen	2.992E-04	BDL	1.188E-04	4.18E-04	0.009
Kjeldahl Nitrogen	0.13	0.24	7.249E-02	4.425E-01	9
Phosphorous	4.447E-02	3.213E-02	2.377E-02	1.004E-01	2
Cadmium	BDL	BDL	BDL	BDL	BDL
Calcium	0.47	0.10	8.556E-02	6.556E-01	14
Chromium	BDL	BDL	1.188E-04	1.188E-04	0.003
Copper	1.035E-02	1.384E-03	1.426E-03	1.316E-02	0.277
Iron	1.319E-02	1.929E-03	4.872E-03	1.999E-02	0.421
Lead	2.450E-03	BDL	BDL	2.450E-03	0.052
Magnesium	6.206E-02	2.752E-02	2.198E-02	1.116E-01	2.35
Nickel	BDL	BDL	BDL	BDL	BDL
Silver	BDL	BDL	BDL	BDL	BDL
Zinc	1.500E-02	1.915E-03	3.684E-03	2.060E-02	0.434
Chloride	1.15	0.85	0.42	2.42	50.987
Sulfate	0.56	0.23	0.24	1.03	21.70
Methylene Blue Active Substances (MBAS)	2.257E-02	1.805E-03	7.724E-03	3.162E-02	.66

1. E-Format Scientific Notation is used for very small numbers.
2. G/D = Gallons per day; LB/D - Pounds per day; PPM = Parts per million; BDL = Below Detection Limit.
3. Head Areas include washbasins and showers; Food Areas include dishwater, galley sink, galley kettle, and scullery sink.
4. In-port crew manning level of 135.

Source: David Taylor Naval Ship Research and Development Center (DTNSRDC) Rept MAT 76-96, "Non-Oily Aqueous Waste Streams on USS Harold J. Ellison (DD-864)", Vol I and II, Dec. 1976.

Table 4-8. Calculated concentrations of surfactants and heavy metals in the East Waterway due to graywater discharges using the Tidal Prism Method.

	Effluent Conc. (ppb)	Dilution Conc. (ppb)	EPA Criteria (US EPA, 1980) (ppb)
Chromium	3.0	0.0045	18.0
Copper	227.0	0.420	4.0
Zinc	434.0	0.658	58.0
Lead	52.0	0.079	25.0
MBAS	660.0	1.0	---

heavy metals present would be at concentrations below and therefore within the acceptable water quality criteria levels set by the U.S. EPA. However, the intertidal area adjacent to the four vessels that would potentially discharge graywater on a continuous basis would not experience an equivalent degree of dilution as calculated. This area may experience concentrations of copper that exceed the EPA criteria levels.

To meet EPA criteria, dilution of a continuous graywater discharge in this area would have to be approximately 57 to 1 for copper, 8 to 1 for zinc, and 2 to 1 for lead.

4.3.3 Regulatory Status

The discharge of graywater by Department of the Defense ships is not prohibited by the Clean Water Act 33.1322.(d) (also see 40 CFR 122.3). However, the Washington State Department of Ecology (WDOE) in a response to the Navy Homeport FEIS, pointed out that such a discharge is in violation of Washington State law RCW 90.48.80. While WDOE has concluded that the proposed discharge would not pose a significant environmental problem, it is concerned that such an activity would set an "undesirable precedence" (WDOE, 1986). The Navy will comply with Washington State law RCW 90.48.80. As stated previously, the Navy has recently determined that retrofitting the DD and DDG vessels with internal graywater collection systems is feasible. The approximate cost would be one-half million dollars per ship. The Navy will work with the appropriate regulatory agencies to develop a compliance schedule for retrofitting.

4.3.4 Toxicity of Graywater

Graywater contains three classes of compounds potentially harmful to the environment depending on the concentrations involved and the loading rates; surfactants or MBAs (the active ingredients in soap and detergents), heavy metals, and oxygen demanding compounds.

Oxygen demanding compounds are not toxic in themselves but can potentially lower the ambient oxygen concentrations in receiving waters below levels required by fish and other animals. This process does not occur rapidly. For this reason, measurements are normally made for a five-day biochemical oxygen demand (i.e., BOD_5). Bodies of water that are already well oxygenated and have direct and nearby flushing with large receiving waters, such as the East Waterway has with Puget Sound, are in little danger of oxygen depletion. Based on a first order tidal flushing analysis of the proposed East Waterway pier and breakwater configuration, the mean residence time of a pollutant discharged to the waterway would be approximately 15 hours. Based on a 5-day BOD, oxygen demand from decomposition of scullery wastes and residues of detergents would be approximately 10 percent complete in 12 hours. The other 90 percent of the demand would occur outside East Waterway where mixing in a larger body of water would insure that negligible reductions in ambient dissolved oxygen would occur. Dilution estimates for the East Waterway result in a dilution factor of 660. At this dilution, and combined with the estimated 20 percent BOD exertion factor (i.e., per day), the predicted depression in dissolved oxygen in the discharge plume will be approximately 0.25 mg/L. The lowest dissolved oxygen concentration observed in East Waterway is 5.3 mg/L in surface waters (FEIS Appendix J). The minimum resultant concentrations of 5.05 mg/L is above the 5.0 mg/L standard set by WDOE for Class B waters (WAC Chapter 173-201, FEIS Appendix J).

Heavy metals are highly toxic to marine life. Table 4-8 indicates that, for those metals of concern and in a conservative case situation, the predicted concentrations after dilution would be below EPA criteria acceptable in marine receiving waters.

Surfactants are toxic to fish and invertebrates in fairly low concentrations. Linear Alkylate Sulphonate (LAS), the principal surfactant used in most laundry detergents has a 96 hr LC_{50}, (the concentration at which 50% of the test animals would be expected to die from a 4 day exposure), ranging from 1.0 to 23.6 mg/L depending on the study species and experimental conditions. (Eisler et al. 1972; Swedmark et al. 1971). The EPA has not set standards for surfactants in receiving waters. However, in view of the fact that they are readily biodegradable and are metabolized by most organisms, an application factor of 0.1 would appear to be reasonable. This means that 10 percent of the lowest reported 96 hr LC_{50} for a sensitive representative species (i.e., 10 percent of 1.0 mg/L or, 0.1 mg/L) may be considered to be environmentally safe. The EPA typically assigns application

factors of 0.1 to compounds that can be metabolized, do not persist in the environment (i.e., complex or biodegrade) or do not biomagnify in the food chain. Compounds which do biomagnify typically have an application factor of 0.01 or less (US EPA 1976). Based on an application factor of 0.1, the predicted concentration of MBAS in the East Waterway is approximately 1.0 percent of the concentration considered herein as safe for aquatic life (0.1 mg/L).

4.3.5 Environmental Consequences

Despite the seemingly large volume of graywater proposed for discharge into the East Waterway in a conservative situation as a result of the Homeport (i.e., without retrofitting the 2DD and 2DDG vessels), significant environmental impact is unlikely. Such a discharge would, however, contribute metals and other pollutants to the overall cumulative operational impacts on aquatic life. In any case, the predicted resultant dissolved oxygen concentration would remain above the standard set by Washington state law.

While the diluted concentrations of heavy metals from the proposed graywater discharge are well within the EPA criteria in East Waterway, the intertidal benthic communities directly adjacent to the four vessels continuously discharge graywater may be impacted to some degree by copper which may exceed the EPA criteria. Copper is more toxic to invertebrates than fish. Invertebrate larval forms are particularly sensitive. The most likely potential impact on biota in this localized area would be through the elimination of a portion of the planktonic larval forms of barnacles, mussels, clams, worms, benthic copepods, amphipods, crabs and shrimp as they settle out. A reduced population size of organisms with elevated body burdens of copper may result. It should be noted that the benthic community in this area is presently highly stressed and in a depressed condition. Predatory fishes and the larger more motile invertebrates such as crabs may tend to avoid the area due to lower prey density. Those that do forage in the affected area will be exposed accordingly. Whether or not this avenue of uptake results in higher body burdens than direct absorption from the water is unknown. The overall impact on fish in the area is likely to be negligible. Due to their limited contact time, migrating salmonids would not be adversely affected. In addition, salmonids have the capacity for detecting and avoiding concentrations of copper as low as 4.0 ug/L at least in freshwater (Sprague and Drury, 1969). This is equivalent to the EPA criteria level and below that concentration which would cause adverse impacts on salmonids and other aquatic life at the chronic exposure level.

Surfactant levels for the East Waterway are projected to be 1000 times lower than the lowest observed LC_{50} in fish. This is a conservative estimate and assumes that no biodegradation, chemical complexation or photolysis would occur. (In fact a significant

amount would occur). For this reason, no adverse impacts are expected from surfactants even in the inshore area adjacent to the discharge.

4.3.6 Alternatives

Five alternatives have been suggested by various agencies and private individuals to remedy the conservative situation whereby the 2 DD and 2 DDG vessels are continuously discharging graywater while in port:

1) Devising special connection hoses to the sewer system
2) Elimination of use of graywater ports
3) Only scheduling the deployment of ships with internal graywater collection systems to Everett
4) Not keep personnel "hoteled" in these ships
5) Retrofit the four ships with internal graywater collection systems.

Special connection arrangements are however, not possible. The discharge ports on DD and DDG vessels number from 15 to 32 above and below water-line. Such an entanglement of hoses would pose an unacceptable time commitment during a period of rapid docking and deployment. The elimination of graywater ports could only be possible by eliminating washroom activities aboard ship. A specific battle group combination requires certain vessels to perform specialized functions in operation and one cannot be substituted for another. As such, no vessels with a present capacity for internal graywater collection can be substituted for the 2 DD and 2 DDG vessels in the proposed battle group. None of the DD 963 or DDG 993 class ships have internal collection systems for graywater. While in Port, it is not possible to eliminate graywater by not having personnel aboard ship. A certain number of key personnel must be present to maintain immediate readiness for deployment. Approximately 50 percent of the crew are expected to remain aboard due to economic reasons. Retrofitting the four vessels with internal collection systems appears to be the most viable alternative. The Navy has determined this to be feasible and will negotiate a schedule for compliance with the appropriate agencies. The implementation of this alternative would reduce the annual discharge of gray water from a maximum of 4.4 million gallons per year (GPY) down to 185,086 GPY. Actual discharge would be closer to 61,695 GPY when using a more probable docking/-departure discharge time in East Waterway of one hour rather than three (maximum).

4.4 Organotin Paint

4.4.1 Purpose and Need for Organotin Antifouling Paints

Fouling communities on ship hulls increase drag which reduces maximum speed, ship availability and increases fuel consumption. Currently, the Navy also uses a cuprous oxide-based antifouling paint. The service life of such paint is approximately 2 to 3 years and requires periodic in-water hull cleaning by SCUBA divers. Organotin paints have a significantly longer service life, about 5 to 7 years. The elimination of in-water hull cleaning will save \$15K to \$75K per hull or an annual fleet savings of \$5 million. In addition, the fleet will have increased operational readiness. A 15 percent savings in fuel costs will be possible due to reduced hydrodynamic drag. This translates into an annual cost avoidance of 3.2 million barrels of diesel fuel worth \$150 million in 1983 dollars with full fleet implementation. Other benefits include increased cruising ranges between refuelings, increased ship maneuverability, decreased sonar self-noise and acoustic signatures, and decreased loss of camouflage on submarines.

4.4.2 Background

The Navy's experience with organotin paints began in the 1960's when approximately 60 vessels (mostly submarines) were painted with early formulations (more toxic than currently proposed ones). This practice was discontinued in the mid 1970's. The Navy and Coast Guard require organotin paints on all aluminum hull craft, because of the potential for galvanic corrosion with copper-based paints.

More recently, through fiscal year 1985, only 15 Navy ships nationwide were painted with tributyltin (TBT) paints. No ships received TBT paint during fiscal year 1986. During fiscal year 1987 no greater than 10 ships will be painted with TBT (Adema, personal communication). Because studies with TBT are ongoing worldwide and because unknowns remain, the possibility exists that Navy ships berthed at the proposed Everett Homeport will not be painted with TBT. However, because some ships may have TBT applied, the analysis and discussion herein takes a conservative approach and assumes all ships will be painted with TBT.

Specific paint formulations of the proposed organotin paints have not been determined. Candidate paints have tributyltin (TBT) as the active biocide. TBT is chemically bound in a co-polymer acrylic matrix that provides a uniform TBT release rate. Various formulations exhibit TBT release rates from 0.1 ug to 1.0 ug/-cm^2/day. To obviate adverse environmental impacts, maximum TBT release rates would be set at 0.15 ug/cm^2/day of painted wetted hull area. There are two ways that TBT may enter the environment, i.e., through leaching action and by dry dock operations when hulls would be sandblasted and repainted. Only the leaching mode of entry will be considered in this discussion. Refinishing operations will not occur in the East Waterway. Such operations will take place in other existing Naval ship maintenance yards.

4.4.3 Regulatory Status

In January, 1986 the US EPA initiated a Special Review of TBT under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). No effluent guidelines or water quality criteria have yet been established for organotins. However, the EPA plans to publish water quality criteria for TBT in April, 1987 (Purcell, personal communication, 1986). Therefore, regardless of the TBT analysis presented later herein, the ultimate acceptability of TBT use by the Navy will be determined upon establishment of water quality criteria and completion of the Special Review.

France imposed a 2-year ban on organotin antifouling paints with more than a percent TBT in 1980 on boats less than 25 meters in length because of concerns over effects on oyster fisheries. In 1984, the paint content of TBT was reduced to 0.4 percent. England banned OT antifouling paints on small shallow draft vessels in 1984. In 1986, England set water quality criteria at 0.02 ug/L and restricted co-polymer formulations to contain no more than 7.5 percent tin by weight (Ross, personal communication, 1986; Champ 1986).

4.4.4 Alternative Actions Considered

Five alternative approaches to controlling marine fouling on Navy ship hulls have been considered (USNSSC, 1984):

- No action;
- Existing copper-based antifouling paints;
- Organotin antifouling paints--initiate implementation;
- Organotin antifouling paints--delay implementation; and
- Other antifouling materials/paints.

No action and the existing copper-based antifouling paints do not meet the Navy's future operational needs. Other antifouling materials/paints have promise for the future but none has been adequately tested and proven effective for routine Navy use. The two alternatives involving organotin paints are identical except for the initiation of the painting program; under either alternative the number of ships painted per year would be small (5 to 20 percent of the Fleet) and complete implementation could not be achieved for 7 to 10 years after program initiation.

From an operational standpoint, the only currently feasible alternative is the use of OT paints. From an environmental impact standpoint, the No Action alternative would have no adverse environmental consequences and might actually have beneficial environmental effects by eliminating the current use of copper-based paints. The two alternative actions involving OT paints would have the same potential environmental impacts at full Fleet implementation, only the timing of action would differ. The

environmental consequences of other antifouling materials/paints cannot be assessed at this time because new biocides have not been identified. Any new copper-based paint formulations should have the same or fewer impacts as the existing copper-based paints. For these reasons, only the environmental effects of OT paints and copper-based paints are discussed in this section.

4.4.5 Summary of Environmental Effects of the Use of Organotin Paint

4.4.5.1 Adequacy of Available Data

The Navy recognizes that the environmental fate and effects of organotins and TBT have been investigated in laboratory experiments but not in field studies. Chronic toxicities, human health effects, degradation rates, bioconcentration/biomagnification, food chain effects, environmental chemistry, and analytical methods need additional investigation. Considerable data do exist, however, and much additional research is planned or ongoing. The U.S. EPA has registered the candidate paints for unrestricted use and the implementation rate for fleet-wide use of OT paints would be slow. The Navy would monitor environmental conditions in Pearl Harbor, HI and Mayport, FL and update their antifouling paint environmental assessment (USNSSC, 1984) by October 1988.

4.4.5.2 Predicted Ambient Organotin Concentrations in Other Harbors

Potential ambient TBT concentrations have been estimated for six case study harbors (USNSSC, 1984). The Navy has estimated TBT concentrations attributable to ship hull releases after full Fleet implementation to vary from 0.0018 ug/L in the Norfolk Harbor to 0.033 ug/L in San Diego Bay. These would appear to represent minor potential impacts when compared with maximum concentrations measured in Norfolk Harbor and San Diego Bay (see below).

4.4.5.3 Effects on Aquatic Life

The U.S. EPA has not yet published water quality criteria for organotins or TBT. The lowest observed acute toxicity level published for saltwater organisms (Table 4-9) is 0.5 ug TBT/L (96-hour LC_{50} for juvenile mysid shrimp). Insufficient chronic toxicity data exist to establish an average TBT concentration to protect aquatic life from long-term exposure. For the purposes of this impact assessment, a 10-fold safety factor has been applied to the lowest observed acute toxicity value to obtain a target average TBT concentration (0.05 ug/L) that is assumed to protect aquatic life against direct toxic/sublethal effects from long-term exposure to dissolved TBT. Zooplankton appear to be the most sensitive organisms to acute exposure to TBT, whereas larger organisms, fishes, and bottom-dwelling organisms appear to be more

Table 4-9. Marine Invertebrate Acute Toxicity Values for Tributyltins

Organism	Chemical*	Bioassay Method **	Test Conc.***	Time (hrs)	LC_{50} (ug/L)	Reference
Mussel - Adult *Mytilus edulis*	TBTO	S	M	96	20-60	NOSC 1981
- adult	TBTO	S	U	96	38	Thain 1983
- larvae	TBTO	S	U	48	2.3	"
Polychaete Worm - Adult *Neanthes Arenaceodentata*	TBTO	S	M	96	10-35	NOSC 1981
- immature subadult	TBTO	S	U	96	5-10	"
Mysid Shrimp - Adult *Metamysidopsis elongata*	TBTO	S	U	96	1-7	"
- subadult	TBTO	S	U	96	2-3	"
- juvenile	TBTO	S	U	96	0.5-1.0	"
Sand Shrimp *Crangon crangon*						
- adult	TBTO	S	U	96	41	Thain 1983
- larvae	TBTO	S	U	96	1.5	"
Barnacle *Balanus amphitrite* (nauplii)	TBTO	S	M	24	3.67	NSRDC 1976

Table 4.9 (Cont.) Marine Invertebrate Acute Toxicity Values for Tributyltins

Organism	Chemical*	Bioassay Method **	Test Conc.***	Time (hrs)	LC_{50} (ug/L)	Reference
Zooplankton *Eurytemora* sp.	TBTO	S	M	24	0.7	Biospherics 1976
Arcartia sp.	TBTO	S	M	96	0.65(EC_{50})	Uren 1983
Nitocra spinipes	TBTO	S	U	96	2.0	Linden et al. 1979
Oyster						
Ostrea edulis	TBTO	S	U	96	210	Thain 1983
Crassostrea gigas	TBTO	S	U	96	290	"
- larvae	TBTO	S	U	48	1.6	"
Green crab - larvae *Carcinus maenus*	TBTO	S	U	96	10	"

* TBTO = Tributyltin Oxide; TBTO is a registered trademark of M&T Chemicals, Rahway, NJ

** S = Static with daily renewal

*** M = Measured, U = Unmeasured

tolerant (Tables 4-10 and 4-11). Maximum water column concentrations of TBT have reportedly been observed that exceed the 96-hr LC_{50} concentration (0.5 ug TBT/L) utilized in the analysis presented here (i.e., Lake Ontario, CN, 0.840 ug/L, Maguire et al., 1982; San Diego Bay, CA, 0.930 ug/L, Valkins et al., 1985; Norfolk, VA, 0.063 ug/L, Perkins, 1985; River Crouch, UK, 2.0 ug/L, Waldock and Miller, 1983). However, maximum water column concentrations are a function of many variables including: distance to TBT source; TBT paint formulation; area of wetted hull exposed; volume of water exposed; and circulation and mixing.

A recent unpublished study (Becerra-Huercho, 1984) reportedly indicates that a lower LC_{50} (48-hour) concentration (i.e., 0.015 ug/L) exists for larvae of the hard shell clam Mercenaria mercenaria. Other studies reportedly identified a 15-day LC_{50} of 0.1 ug/L for mollusk larvae (Beaumont and Budd, 1984) and an 8-week LC_{50} of 0.3 ug TBT/L for amphipod larvae (Laughlin et al., 1984). These latter studies may be best applied to effects regarding chronic toxicity of TBT to marine life. Research to date reportedly indicates that water column TBT concentrations greater than 0.1 ug/L exert an adverse effect on aquatic organisms (Goldberg, 1986). While certain TBT paint formulations may be highly toxic to aquatic life, the Navy will comply with US EPA approved formulations to minimize the possibility that Port Gardner water column concentrations do not exceed the soon to be promulgated water quality criteria for TBT. Compliance with these formulations will minimize the probability that significant impacts to Port Gardner aquatic life will occur.

The bioavailability of TBT present in water is not precisely known. Bioconcentration factors ranging from 2600 for whole sheepshead minnows to 19,500 for whole flatfish have been reported (Table 4-12). Fish appear to metabolize TBT to less toxic forms and rapidly depurate accumulated TBT after exposure ceases. The consequences of various body burdens of TBT have not been studied in detail. Flatfish which had accumulated 31,200 ug TBT/kg at exposure concentrations of 1.6 ug TBT/L, had a 66 percent survival rate over 70 days (Nose, 1983). Life cycle chronic toxicity tests with TBT will assist in establishing acceptable limits for body burdens to protect aquatic organisms (USNSSC 1984). TBT biomagnification in aquatic food chains has not been examined sufficiently to indicate whether or not TBT concentrations in organisms would increase at each trophic level. Therefore, the effect(s) of potential biomagnification in aquatic food chains cannot be assessed at this time.

Based upon the above discussion regarding TBT and the various unknowns present regarding bioavailability, and assuming that Navy ships using TBT are stationed at Everett, a monitoring program to assess potential impacts on the aquatic ecosystem of East Waterway would appear to be beneficial.

Table 4-10. Marine Fish Acute Toxicity Values for Tributyltins

Organism	Chemical*	Bioassay Method **	Test Conc.***	Time (hrs)	LC_{50} (ug/L)	Reference
Flatfish *Citharichthys stigmaeus*	TBTO	S	M	96	20	NOSC 1981
Sheepshead minnow *Cyprinodon variegatus*	TBTO	FT	M	96	>1.5<3.2	Ward et al. 1981

* TBTO = Tributyltin Oxide
** S = Static, FT = Flow-through
*** M = Measured, U = Unmeasured

Table 4-11. Other Marine Data for Tributyltins

Organism	Chemical	Test Duration	Effect	Result	Reference
Clam	TBTO	96 hrs	Survival (static test)	100% at 150 ppb	NOSC 1981
Peotothaca staminea	TBTO	10 days	Survival (static test)	20% at 76 ppb (initial conc.)	
Mussel	TBTO	10 days	LC_{50} (static test)	15 ppb (initial conc.)	"
Mytilus edulus	TBTO	7 days	Survival (static test)	w/50-95% reduction in 4 days	
				0% at 76 ppb	"
Phyloplankton	TBTO	96 hrs	Productivity	No effect < 2 ppb	
Dunaliella sp.				Highly toxic at 10 ppb	"
Copepod	TBTO	24 hrs	Survival	0% at 1 ppb	"
Acartia tonsa					
Phytoplankton					
Rhodomonas	TBTO	96 hrs	Productivity	No effect at 5 ppb	"
Skeletonema costatum	TBTO	5 days	Algistatic response	1.0 - 18 ppb	Thain 1983
Tetraselmis svecica	TBTO	5 days	"	560 - 1000 ppb	"
Sheepshead Minnow	TBTO	7 days	LC_{50}	0.91 - 3.5 ppb	Ward et
Cyprinodon variegatus		14 days	LC_{50}	0.70 - 1.4 ppb	al. 1981
		21 days	LC_{50}	0.67 - 1.4 ppb	"
Shore Crab - Larvae	TBTO	14 days	50% survival	6.2 days at 25 ppb	Laughlin &
Hemigrapsus Nudus				5.8 days at 50 ppb	French 1980
				4.8 days at 75 ppb	"
Sheepshead Minnow	TBTF	28 days	Growth (no observed	Toxic @ 0.34 ppb	M&T Chemicals
Cyprinodon variegatus			effect concentration)		1984a

Table 4-11. Other Marine Data for Tributyltins (cont.).

Organism	Chemical	Test Duration	Effect	Result	Reference
Mysid Shrimp *Acenthomysis sculpta*	TBT	44 days	Reproduction (no observed effect concentration	Toxic @ 0.09-0.19 ppb	M&T Chemicals 1984b
Alga (*Skeletonema costatum*)	TBTO	14 days	Cell growth (EC_{50})	Toxic @ 0.13-0.25 ppb	Davidson et al. 1986
	TBTO (Alkyl sourced)	14 days	Cell growth (EC_{50})	Toxic @ 0.064 ppb	Davidson et al. 1986
Lobster larvae *Homarus americanus*	TBTO	24 days	No survival	< 2 days at 15 and 20 ppb 4 days at 10 ppb 6 days at 5 ppb	Laughlin & French 1980 "
		24 days	Development rate larval growth	No effect at 1 ppb (same as controls) Significant decrease at 1 ppb	" "
Amphipod *Orchestoidea californiana*	TBTF	9 days	Survival	80% in controls 87% at 0.5 ppb 60% at 1.0 ppb 75% at 3.0 ppb 53% at 6.0 ppb 20% at 10.0 ppb 7% at 15.0 ppb	Laughlin & & Guard 1981
Gammarus oceanicus	TBTO & TBTF	8 weeks	Larval survival	0% at 3.0 ppb Significant reduction at 0.3 ppb	Laughlin et al. 1982

Table 4-11. Other Marine Data for Tributyltins (cont.).

Organism	Chemical	Test Duration	Effect	Result	Reference
Clam					
Rangia cuneata (adult)	TBTA	17 days	Survival	20 ppb	Good et al. 1978
			No survival	1 ppm	
			High mortality	0.10 ppm (near lethal dose)	"
Rangie Cuneata (juvenile)	TBTA	20 days (closed system)	No survival	40 ppb	"
			High mortality	20 ppb	"
Estuarine Species: Gambusia affinis, Poecilla latipinna, Fundulus grandis	TBTA	12 days (closed system)	No survival	20 ppb	
Fishes (Estuarine & Marine): Gambusia affinis, Poecilla latipinna, Heterandia formosa, Fundulus grandis, Arius felis, Mugil cephalus, Cyprinodon varigatus, Menidia berylina, Micropogon undulatus	TBTA	2 weeks	Threshold conc. below which no deaths occurred	4 - 6 ppb	Good & Dundee 1980

Table 4-11. Other Marine Data for Tributyltins (cont.).

Organism	Chemical	Test Duration	Effect	Result	Reference
Molluscs					
Rangia cuneata	TBTA	Not Available	Threshold conc. below which no deaths occurred	50 ppb.	"
Crassostrea virginica	"	"		40 - 80 ppb	"
Crustaceans					
Paleometes sp.	TBTA	Not Available	Threshold conc. below which no deaths occurred		"

Table 4-12. Summary of Bioconcentration Data for Tributyltins

Organism	Water Concentration (ug/L)	Chemical	Exposure Period (Days)	Tissue	Bioconcent. Factor	Reference
Sheepshead minnow *Cyprinodon variegatus*	1.6 ± 0.36	TBTO	58	whole fish	2,600x (equilibrium not reached)	Ward et al.
				muscle	1,810x	"
				head	2,120x	"
				viscera	4,580x	"
	0.18 ± 0.11	TBTO	167	liver	37,000x	"
				muscle	940x	"
				viscera	3,900x	"
	0.32 ± 0.27	TBTO	167	liver	20,000x	"
				muscle	740x	"
				viscera	2,100x	"
	0.48 ± 0.68	TBTO	167	liver	52,000x	"
				muscle	1,600x	"
				viscera	2,900x	"
	1.0 ± 1.1	TBTO	167	liver	41,000x	"
				muscle	1,200x	"
				viscera	2,500x	"
				remains	750x	"

Table 4-12. (Cont.) Summary of Bioconcentration Data for Tributyltins

Organism	Water Concentration (ug/L)	Chemical	Exposure Period (Days)	Tissue	Bioconcent. Factor	Reference
				F_1 generation		
	0.18 ± 0.11	TBTO	28	whole fish	1,800x	"
	0.32 ± 0.27	TBTO	28	"	1,600x	"
	0.48 ± 0.68	TBTO	28	"	3,000x	"
	1.0 ± 1.1	TBTO	28	"	2,600x	"
Common Flatfish *Citharichtys stigmaeous*	1.6	TBTO	70	whole fish	19,500x	NOSC 1983
Oyster *Crassostrea gigas*	0.15 ± 0.05	TBTO	21	whole	6,000x	Thain 1983
	1.25 ± 0.32	TBTO	21	whole	2,000x	"
Ostrea edulis	0.15 ± 0.05	TBTO	21	whole	1,000x	"
	1.25 ± 0.32	TBTO	21	whole	1,500x	"
Mussel *Mytilus edulis*	0.6	TBTO	47	gill	7,300x	Laughlin 1983 (In USNSSC, 1984)
				mantle	2,000x	
				whole	2,700x	"

Table 4-12. (Cont.) Summary of Bioconcentration Data for Tributyltins

Organism	Water Concentration (ug/L)	Chemical	Exposure Period (Days)	Tissue	Bioconcent. Factor	Reference
Mud crab *Rhithropanopeus harrisii*	1.3	TBTO	6	carapace	109x	Evans & Laughlin 1984
				hepato-pancreas	26x	
				testes	3x	"
				gills	185x	"
				chelae muscle	7x	"
Green Alga *Ankistrodesmus flacatus*	1.5 - 40	TBTO	7-28	whole	1,900x to 47,000x	Maquire et al. 1984

4.4.5.4 Organotin Concentrations and Effects on Sediments

The suspended sediment-water partition coefficient for TBT has been reported to be 3000 ug/kg sediment/ug/L water at 10 mg/L total suspended solids and 700 ug/kg/ug/L at 100,000 mg/L total suspended solids. Newly deposited sediments would, therefore, have TBT concentrations (ug/kg) 3000 times greater than the ambient water concentrations (ug/L), when the solids concentration is 10 mg/L. At an ambient TBT concentration of 0.05 ug/L, the sediment concentration should be approximately 150 ug/kg (USNSSC, 1984). Preliminary results of a standard sediment bioassay indicate that sediments containing 500 ug/kg TBT would not cause adverse effects on aquatic organisms (USNSSC, 1984). However, bioaccumulation by benthic organisms may be expected to occur.

4.4.5.5 Environmental Chemistry and Fate

The environmental chemistry and fate of TBT in estuaries are complex and not completely understood. How released TBT would partition among water, biota, sediment, surface microlayer, and atmosphere has not been experimentally investigated. Reported degradation rates vary from a 24-day half-life for fungal cultures to an 815-day half-life for biodegradation in anaerobic sediments. TBT appears to degrade by dealklyation to the dibutyl, the monobutyl, and ultimately to the inorganic tin species, but the rates and predominant mechanisms for these reactions in estuarine waters and sediments have not been determined. For purposes of this assessment, a TBT decay/loss rate of 2 percent per day has been assumed to reflect the combined effects of TBT losses by sedimentation, photodegradation, microbial degradation, biological uptake, volatilization, and other mechanisms that might detoxify TBT (USNSSC, 1984).

4.4.5.6 Health Effects

Because the Navy will comply with US EPA water quality criteria to be promulgated for tributyltin, no adverse human health effects from the proposed action are anticipated. Human exposure to TBT as a result of the proposed action could potentially occur in shipyards when OT paint is applied or removed, or when people consume seafood containing TBT. The target ambient TBT concentration (0.05 ug/L) used in this assessment as an acceptable concentration to protect aquatic life from long-term TBT exposure is lower than that presumed needed to protect humans (USNSSC, 1984). There are no EPA criteria or standards established for TBT with respect to human health.

4.4.6 Organotin Mass Loading in East Waterway

The projected TBT mass loading to the East Waterway from Navy ship hull releases are the product of the TBT release rate and the wetted hull area of Navy ship present. For the purpose of a

conservative or conservative approach, it is assumed for calculations presented here that all 16 vessels would be present simultaneously. Smaller support vessels (e.g., tug boats) were not included since they are not part of the Navy Fleet.

Organotin release rates or mass loadings per unit of wetted hull surface area have not been measured for ship hulls in natural waters. A few Navy ships have been painted with OT antifouling paint on an experimental basis, but field measurements of OT loadings have not been made. The David Taylor Naval Ship Research and Development Center has measured release rates of organotin under laboratory conditions for the copolymer paints being evaluated for fleetwide use. They have found tributyltin release rates to be less than 0.1 to 1.9 ug TBT/day/cm^2. To minimize the potential for adverse environmental effects and to allow some flexibility for paint usage, the Navy would not use paints with a release rate higher than 0.15 ug TBT/day/cm^2.

Mass loading estimates for the East Waterway are summarized in Table 4-13. A total mass loading estimate of 137.6 g/day was calculated. Actual measurements of hull surface areas were not available, therefore calculations were based on gross dimensions. The maximum length, width and draft for each vessel was used. To adjust for hull curvature 5 percent was added to these area calculations.

4.4.7 Ambient TBT Concentration in East Waterway: Tidal Prism Approach

To obtain an estimate of steady-state OT concentrations in East Waterway, the following assumptions and calculations were made:

- o OT mass loadings are uniform and continuous from the average wetted ship hull areas in East Waterway
- o All organotin is present as the tributyltin cation;
- o TBT is 100-percent dispersed in the water column;
- o TBT decay or loss from the water column is 2.0 percent per day;
- o TBT is the toxic substance and has the same toxicity whether it is freely dissolved or adsorbed onto suspended particles in the water column;
- o TBT is immediately and thoroughly mixed in the tidal excursion segment to which it is released;
- o The initial TBT concentration (C_o) is the TBT mass loading during the first tidal cycle divided by the mean water volume for the segment;

Table 4-13. Tributyltin loading rates based on a conservative estimate of conditions in the East Waterway, Everett, Washington, for the proposed Navy homeport.

Ship Class	No. Present	Length (Ft)	Beam (Ft)	Draft (Ft)	Wetted Hull Surface Area (cm^2)	Leaching Rate $ug/cm^2/day$	Loading Rate g/day	Total Loading Rate g/day
CVN	1	1092	257	41.1	273,738,250	.15	41.060	41.06
CG	2	564	58	31.	49,045,083	.15	7.357	14.714
CGN	2	721	73	30.	71,111,325	.15	10.667	21.333
DD	2	564	55	30.	47,019,834	.15	7.053	14.106
DDG	2	564	55	33	49,630,117	.15	7.445	14.889
FFG	4	445	47	24.9	31,211,032	.15	4.682	18.727
MCM	2	224	39	11.3	10,341,719	.15	1.551	3.103
AD	1	643	85	24	64,289,961	.15	9.643	9.643
								137.575

- The tidal exchange coefficient is the mean tidal exchange volume divided by the mean high tide volume of the segment; and

- Steady-state ambient TBT concentrations for the local tidal excursion segment can be estimated by dividing the initial TBT concentration by the tidal exchange coefficient.

The above assumptions reflect the application of Ketchum's (1951a, 1951b) tidal prism or modified tidal prism method for estimating pollutant concentrations and flushing rates from estuarine systems. The application of these methods to East Waterway may not yield true representations of the hydrodynamics present, but it does provide an assessment of the magnitude of pollutant concentrations and accumulation.

The assumption that all organotin released from ship hulls is dissolved TBT may not be correct. Marine biofilms, that are comprised principally of bacteria, diatoms, algae, and their exudates, develop on ship hulls coated with OT paint and could affect the nature and magnitude of OT releases (Guard et al., 1983). Sulfate-reducing bacteria in biofilms could produce sulfide that would react with TBT to form insoluble tributyltin sulfide (TBTS). In addition, the exudates (nondiffusable uronic acid containing polysaccharides) may be expected to complex with OT in the biofilm and retard TBT release to the environment (Guard et al., 1983). TBT-tolerant microorganisms in the biofilm could metabolize some TBT to a dibutyltin compound that would be released from the biofilm.

Recent OT measurements in two commercial marinas indicate that dibutyltin concentrations are positively correlated with TBT concentrations and suggest that a significant portion of OT released from hull coatings could be dibutyltin or that TBT degradation is occurring in the water column (USNSSC, 1984). If a significant portion of OT released from ship hulls is not TBT or the TBT release rate is significantly less than that measured in the laboratory (painted panels with no biofilms), the projected ambient TBT concentrations may be overestimated.

The assumption that TBT is lost from the water column or decays at a rate of 2 percent per day was made to represent the combined effects of several processes. TBT adsorbs on particulate matter and, therefore, some of the released TBT would be associated with suspended material in the receiving waters. At typical suspended solids concentrations (10 to 20 mg/L), approximately 95 percent would be adsorbed on solids. The quantity of TBT that settles to the bottom sediments in the receiving waters and where the sedimentation occurs would depend on the particle size/density of the suspended material and local hydrodynamic conditions. If a substantial portion of the discharged TBT adsorbs on suspended

material and settles to bottom sediments, then the estimated TBT aquatic organisms in the water column would be reduced accordingly, and aquatic organisms in the water column would be exposed to lower TBT concentrations. TBT could also be lost from the aqueous phase of the water column by photodegradation, microbial degradation, volatilization, and biological uptake.

Steady-state concentrations (C_{ss}) attributable to ship hull releases were calculated with the following equation:

$$C_ss\ (ug/L) = \frac{A \times k}{v x (r+d) x n}$$

where:
A = wetted hull area (cm^2) of Navy ships
k = TBT release rate = 0.15 ug TBT/cm^2/day
v = high tide volume of mixing segment (2)
r = tidal exchange coefficient (tidal cycle^{-1})
d = TBT decay/loss rate (tidal cycle^{-1}) from water column = 2%/day
n = number of tidal cycles per day = 2

As a result of these calculations, the estimated ambient TBT concentration predicted for East Waterway is 0.04 ug/L.

4.4.8 Environmental Impacts on East Waterway

Although water quality criteria for TBT have not yet been established by the US EPA, such criteria are due to be published in April, 1987 (Purcell, personal communication). In the meantime, the predicted conservative ambient concentration in the East Waterway (i.e., 0.04 ug/L) is estimated to be below the level (i.e., 0.05 ug/L) generally considered to be acceptable to protect aquatic life (USNSSC, 1984). The analysis of TBT presented herein is based upon various conservative assumptions regarding TBT, flushing and mixing, etc., in the waters of East Waterway. Regardless of the concentrations predicted in this analysis, the Navy will comply with the forthcoming water quality criteria to be promulgated by the US EPA regarding TBT. Therefore, the predicted or actual concentrations of TBT present are not expected to cause significant biological perturbations to the aquatic environment of the East Waterway or Port Gardner as a whole. It is possible, however, that benthic communities directly adjacent to the ship hulls may be impacted as a result of close proximity and chronic exposure. Potential effects from such sub-acute chronic exposure could include impaired growth, survival and reproductive success of individual resident organisms. If trophic biomagnification occurs, higher levels of the food chain such as resident fishes and crabs would be most affected. It should be pointed out that benthic communities present in much of the potentially affected area are currently highly stressed from human activities (i.e., low species diversity, low biomass and dominance by polychaetes). (For a description of the benthic community present, refer to

Appendices S, T and R of the Navy FEIS). The concentrations of TBT within 10 meters of the hulls will probably be higher than predicted for the whole harbor. Predicted concentrations in the quays of the Naval Station at San Diego were approximately 6 times higher than that predicted for the majority of the harbor. A determination of whether or not this would actually occur in the East Waterway would probably require actual monitoring with the ships in place.

Because the Navy will comply with US EPA water quality criteria for TBT, impacts of ambient TBT on migrating juvenile salmon are expected to be minimal. Although precise salmon migration time through the East Waterway is not known, it is not likely to be more than one or two weeks. Therefore, the potential for significant bioaccumulation of TBT by juvenile salmonid out-migrants is small whether the source of TBT be directly from the water or through feed organisms. Residence time of juveniles in areas where the highest TBT concentrations might occur would likely be reduced due to the anticipated high degree of human activity in the area. Again, monitoring of these quay areas would be necessary to determine the actual concentration of TBT present in water, sediments, and biota. The Navy has not committed to monitoring of TBT in East Waterway.

While a specific hydraulic analysis has not been conducted to evaluate the impact of organotin (or graywater) on Snohomish River wetland areas, use of the Navy's oil spill model (see Chapter IV of the Navy FEIS) appears to offer a reasonable conservative approximation of organotin (or graywater) transport. Based upon the Navy's oil spill model it appears that, at least for surface waters, water movement and dispersion out of the East Waterway to the Snohomish River would be limited. Therefore, adverse impacts to wetlands or shoreline areas of the Snohomish River delta from organotin paints (or graywater) originating in the East Waterway are expected to be minor. Some TBT could be conveyed to wetlands or shoreline areas via subsurface (i.e. saline) water movement into such areas. However, compliance with the soon-to-be promulgated US EPA water quality criteria for TBT will protect against adverse impacts to these wetlands.

4.5 Oil Storage Facilities

Please refer to the Navy FEIS for a discussion of the impacts to the environment concerning Oil Storage Facilities. The following additional material has been developed as a result of comments made during the U.S. Army Corps of Engineers' scoping process for the DEISS and/or from new information resulting from investigations completed since release of the Navy's FEIS.

Navy ships are required to maintain their fuel levels at a minimum of 85% of storage capacity. The Everett Homeport site will function only as a "topping off" facility to maintain the ships at

the required fuel levels. The ability to "top off" the ships in their berths is far more desirable from an operational readiness, vessel traffic, and safety standpoint than "topping off" at Manchester. It has been pointed out that the basic base plans submitted to Congress did not include fuel storage facilities at the Everett site. Originally, open-water barge transfers of fuel were planned. Although this is more costly, it is still a viable interim alternative.

Fuels would be delivered to the Homeport site via barge from the Manchester fueling station. The barge would transfer fuels to a shore-based tank farm from the existing Norton Terminal Wharf in the Snohomish River adjacent to the Homeport facility during this operation. The probability of spilled oil contacting various shorelines within Port Gardner and the probable biological impacts on any such occurrence are discussed in the Navy FEIS.

The oil storage facility tank farm will be enclosed within an impermeable diked containment area capable of handling all of the tank's contents should a major leak occur. Safety procedures are outlined in the Navy's FEIS. All oil spill containment equipment will be housed on-site in the public works or port services buildings when not in use. During all fuel barge off-load operations, oil spill equipment would be deployed.

The Norton Terminal wharf location was chosen because life cycle cost analyses determined that the installation of a "top-off" facility at the Everett base would cost less over time than fueling each ship individually by barge while in their berths or refueling each ship directly at Manchester. Manchester facilities cannot handle the aircraft carrier Nimitz. The proposed location of the fuel barge berth is cost-effective because an existing wharf is utilized, precluding the need to construct a new fueling point, thereby reducing in-water construction. Additionally, the proposed location is significantly less congested and would have a larger docking area than a site within the East Waterway. A number of parties have objected to the Navy's proposed fuel terminal location. The feasibility of moving the fuel transfer facilities to an East Waterway location is being reanalyzed in light of possible interference with commercial shipping or compromising Naval siting criteria which could negatively affect any future expansion plans at the Norton Terminal site.

4.5.1 Oil Spill Potential and Impacts

The vulnerability of Port Gardner shoreline areas including Jetty Island, Smith Island, and other associated Snohomish waterway shoreline habitats were addressed in Chapter IV of the Navy's Final EIS. Potential oil spill impacts on these shoreline habitats were modeled and evaluated based on spills of diesel fuel marine (DFM) and jet fuel (JP-5) occurring in the Snohomish River and inside the East Waterway. The model simulation was run for

every combination of 7 wind scenarios, 2 river flow conditions, 4 spring tides and 2 neap tide phases. Results of that simulation, with a discussion of potential biological impacts, are presented in Chapter IV of the Navy's final EIS. Locating the oil transfer facility within East Waterway would, as noted in the oil spill impact modeling, result in fewer impacts to the Snohomish River and related environs. It would, however, increase potential impacts to shoreline areas of East Waterway and Port Gardner.

Based on the Navy's oil spill model, a conservative scenario suggests that those sensitive shoreline areas identified in the FEIS would be covered with JP-5 or DFM, cause severe impairment and/or death to the associated biota, and require extensive clean-up. A conservative situation would require restoration of habitat and organisms.

Please refer to the Navy FEIS for further discussion of the impacts to the environment concerning oil spills.

4.6 Cumulative Impacts of Construction and Operation

4.6.1 Construction Impacts

The majority of construction related impacts resulting from the proposed project are associated with dredge and dredge disposal activities. Therefore, cumulative impacts of the project necessarily focus on these activities.

Because the proposed Navy homeporting project would displace Port of Everett facilities, relocation of the Port facilities would occur. The area for relocation has tentatively been identified as the Hewitt Avenue (Terminal) and nearby WEYCO areas, located slightly south and east of the proposed Navy facility, in Port Gardner. Dredging of sediments in this area would occur. The volume of material to be removed has been estimated at 235,000 cubic yards. Chemically these sediments appear to be less contaminated than those identified for dredging from East Waterway (Anderson and Crecelius, 1985; Port of Everett, 1986).

A total of 51,500 cubic yards of material have been identified as contaminated, 13,500 cubic yards as debris, and 170,000 yards as relatively clean material (Section 10/404 permit application of Port of Everett to U.S. Army Corps of Engineers, September 1986). Based on these estimates, a total of 51,500 cubic yards of contaminated material will require confined disposal. Assuming this contaminated material can be combined with those sediments proposed to be dredged and disposed of by the Navy, this would represent approximately a 6 percent increase in the volume of contaminated sediments to be handled as part of the proposed project. The Port has submitted an application to the U.S. Army Corps of Engineers to dispose of contaminated and uncontaminated dredge materials, excluding debris, at RAD CAD. That project is

being evaluated under separate permit review. The feasibility and acceptability of combining the Port's contaminated material into RAD CAD will be subject to separate environmental review conducted during the processing of the Port's application.

Because the Hewitt Avenue and WEYCO areas proposed for dredging appear to contain sediments with lower contaminant concentrations that those from East Waterway, the potential water quality and related biotic impacts of dredging and disposal are not expected to be as great as those indicated for East Waterway sediments. Studies have not, however, been conducted to determine the physicochemical properties of these sediments. Thus, the tendency for contaminants present to remain sediment bound or to partition into the water column remains unknown.

In terms of cumulative impacts, the additional volume of contaminated sediments contributed by the Port of Everett would not be expected to increase the magnitude of event-related water quality impacts over those previously described. It would, however, extend the duration of such impacts during the additional time required for dredge disposal activities.

The following analysis combines the 928,000 cubic yards of contaminated sediments estimated for East Waterway with 51,500 cubic yards estimated for the proposed Port of Everett dredge sites. This additional material represents approximately 6 percent of the total contaminated sediments. During dredging and open-water disposal (CAD site) a contaminated mass release (including particulate bound contaminants) of 2.0 and 2.0 to 2.1 percent, respectively, were estimated by the U.S. Army Corps of Engineers for Everett East Waterway sediments (U.S. Army Corps of Engineers, 1986). Based on a dredge volume of 979,500 cubic yards of contaminated sediments with a bulk density of 1.25 g/cm^3 (Appendix D of the DEISS) a maximum total contaminant mass release to the water column of Puget Sound of 38,400 metric tons (i.e., 18,700 plus 19,700) is estimated to occur during dredge and open-water placement of all contaminated sediments.

This total mass release for contaminated materials would occur over a 3 week period in FY 1987 and a 3 month period in FY 1988 (i.e., 97,000 cubic yards in 1987 and 882,500 cubic yards in 1988). Because of the relatively low current velocities present at the proposed discharge site and in East Waterway the major portion of sediment released to the water column is expected to settle within the dredging and/or disposal area.

The gross quantity of particulates discharged to Puget Sound from non-point sources (i.e., river drainage, shoreline erosion, and atmospheric input) is estimated to be 11.79×10^5 metric tons per year (Galvin et al., 1984). Thus, mass release of particulates from contaminated sediment dredge and disposal for the proposed project would be approximately 0.3 and 2.9 percent of the total

yearly non-point source input to Puget Sound for 1987 and 1988, respectively (i.e., 3.62×10^3 mt/11.79×10^5 mt=0.3 percent and 3.27×10^4 mt/11.79×10^5 mt=2.9 percent).

The advection or transport of particulate matter (or solids) out of Puget Sound has been estimated to be 9 percent of that entering the Sound (Galvin et al., 1984). Sedimentation within the Sound is the ultimate sink for the remaining 91 percent of particulates. Thus, over the short-term, contaminated sediments disturbed as a result of the proposed project will be resuspended and entrained into the water column. The majority of these sediments may be expected to settle out within a short distance of the dredge and disposal operations and do not represent a threat to the overall water quality of Puget Sound. Short-term adverse water quality conditions will occur as a result of the proposed dredge and disposal operations but, as noted earlier, dilution within a short distance of these activities will reduce contaminant concentrations to below established water quality criteria. Bioaccumulation of contaminants may occur, however, the significance of such accumulation is unknown. Because the US EPA water quality criteria include safety factors for those contaminants that biomagnify, bioaccumulation is not expected to result in measurable impairment to the aquatic food chain as a result of the proposed project.

4.6.2 Operations Impacts

The cumulative impacts of project operations on water quality requires that the additive effects of the previously described impacts be quantified. Because of the inherent variability of the predicted impacts, such quantification and cumulative assessment is difficult. Possible oil spills combined with measurable concentrations of TBT (from antifouling paint) and copper (from graywater) may act synergistically to result in water quality conditions below those predicted herein. However, because of the mitigation provided (See Section 12.2.2.) and because of the infrequency of such compounding events, the cumulative operations impacts to water quality and related biota are not expected to result in overall adverse impacts.

Relative to East Waterway as a whole, removal of the presently contaminated sediments is expected to result in at least temporary enhancement of water quality. However, ongoing discharge of contaminants from the point and non-point sources adjacent to East Waterway may be expected to result in adverse impacts. Also refer to the previous discussion in this section. In addition, in terms of cumulaltive impacts, the additional volume of contaminated sediments contributed by the Port of Everett development during dredge and disposal activities would not be expected to increase the relaltive magnitude of event related water quality impacts over those previously described. It would, however, extend the duration of such impacts during the extra time required for the

additional dredge and disposal activities. Based on the additional dredge material estimated for the Port of Everett, this would amount to an increase of approximately 6 percent.

5. FISHERIES RESOURCES IMPACTS

5.1 Project Design and Habitat Changes

The Homeport project design would alter the existing shoreline along those parts of the Snohomish Channel and East Waterway that are within the project boundaries. This alteration is necessary for wharf construction and the mooring/turning basin in East Waterway. Figure 5-1 identifies segments of the proposed shoreline that would have uniform slopes and substrate type. Table 5-1 summarizes the length, the amount of square footage between +8 and -8 MLLW, and the substrate type within each segment.

Under the proposed shoreline configuration there would be an increase of approximately 2,700 lineal feet and 83,521 square feet (between +8 and -8 MLLW) of shoreline over existing conditions within the Homeport project boundaries. The value of such an increase is directly related to the quality of habitat that would be added to the area, as well as the quality of habitat it would be replacing.

Table 5-1. Tidal zone habitat characteristics for shoreline segments depicted in Figure 5-1.

Segment	Slope	Approximate Length (ft)	Approximate Area (sq ft)	Substrate Type
A	2.5:1	1,250	49,172	Existing wharf, riprap
B	2.5:1 and 8.75:1	1,700	155,350	Riprap, rocks gravel/sand, riprap,
C	4:1	950	65,970	Riprap
D	1.5:1	3,300	95,187	Riprap (breakwater)
E	2.5:1	1,700	73,238	Riprap, south wharf
F	2.75:1	2,150	100,663	Riprap, central wharf
G	2.75:1	1,200	56,180	Riprap, future wharf

Within the Snohomish Channel a substantial amount of higher quality habitat would be added to what currently exists. Segment B in the proposed shoreline configuration (Figure 5-1) consists of a 1700 foot long shoreline segment that would have a compound

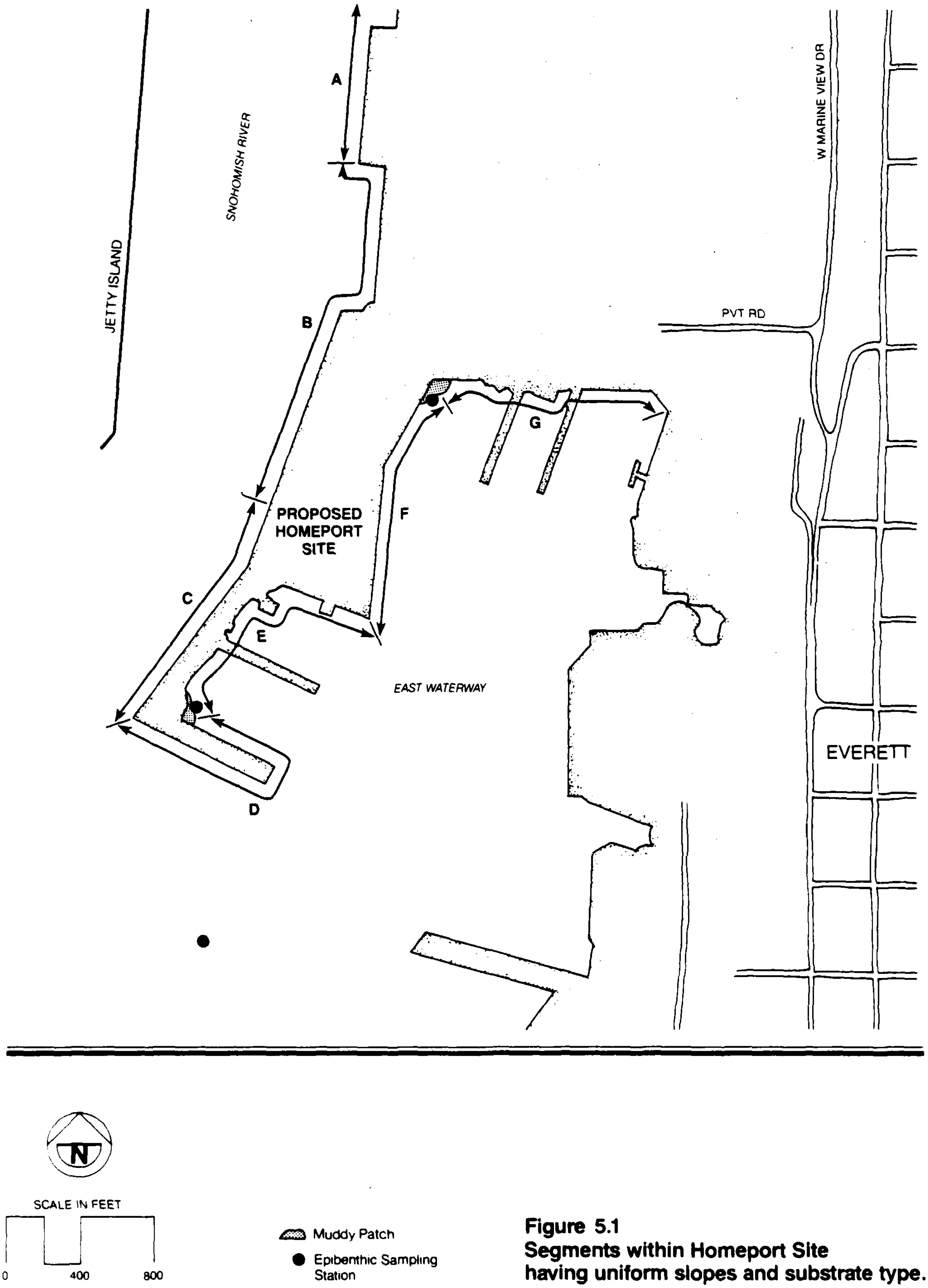


Figure 5.1
Segments within Homeport Site having uniform slopes and substrate type.

slope. The compound slope would include a relatively flat bench (8.75:1 slope) that is 70 feet wide and would occur at about the +5 to -3 MLLW elevation. The shoreline above and below the bench would be a steeper (2.5:1) riprapped shoreline that is similar to existing conditions. The substrate of the 70 foot wide bench would be a mixture of sand, gravel and rocks. The design details presented at this time are tentative. While the basic concept has been accepted by most of the resource agencies, final design details have not yet been approved. Its purpose is to provide high quality habitat for juvenile salmonid prey items and thus serve as a feeding area for juveniles as they migrate through the estuary. This design would add approximately 119,000 square feet of gently sloped intertidal habitat. Currently this type of habitat does not exist on the left bank side of the channel in that area. Therefore, this portion of the proposed shoreline is a major improvement over existing conditions within the Snohomish Channel.

Another shoreline segment that represents an addition to the existing conditions is Segment D (Figure 5-1). This segment would be a steeply sloped (1.5:1) breakwater to serve as protection for the carrier pier. The breakwater would include approximately 3,300 lineal feet of shoreline (1,650 feet on each side) and would add about 95,187 square feet of habitat between +8 and -8 MLLW. This area would be armored with large riprap rock. Addition of this type of habitat is probably of less value to juvenile salmonids than the beach in Segment B because it would not tend to support as many prey organisms as a more gently sloped beach with smaller substrate size.

A salmonid migration gap has been proposed between the carrier pier breakwater (Segment D) and the south mole (Segment E). This gap is designed to prevent juvenile salmonids from migrating out along the carrier breakwater away from the existing shoreline, but rather encourage them to use their present migration route through East Waterway. The gap would be approximately 12 feet wide, have sides at a slope of 1.5:1 on the breakwater side of the gap, and 2.5:1 on the south mole side, and would have a depth corresponding to -7.5 MLLW. The gap would be spanned with a walkway providing access to the breakwater for maintaining navigation aids located at the end of the breakwater.

Segments A, C, and E (Figure 5-1) would be similar to existing conditions both in terms of slope and substrates. Proposed slopes are slightly more gradual than the existing slopes (4.0:1 vs 2.75:1 in Segment C and 2.5:1 vs 2.0:1 in Segment E). Also, substrate type would be similar to the large riprap that currently exists, but would be more uniform material with less debris and refuse.

Segment F (Figure 5-1) of the proposed shoreline would replace Segments E and F identified in Section 3.2.1. of the DEISS. The

existing Segments E and F have patches of muddy/silt/sandy areas interspersed within the large riprap material that dominates these segments. The proposed shoreline (Segment F) that would replace the existing segments would be a uniform substrate of large riprap material and would not include the patches of muddy substrate that presently exist.

The value of these existing muddy areas that would be lost appears to be minimal in providing prey organisms for juvenile salmonids. Although these muddy areas support large numbers of epibenthic organisms (particularly harpacticoids), these organisms were not consumed by any of the juvenile salmonids sampled from East Waterway for stomach content analysis. As stated earlier, the majority of the existing East Waterway shoreline is steeply sloped with riprap or some type of large debris (broken concrete, asphalt, and pilings). Based on the stomach content analysis (Appendix R of the Navy FEIS), the existing shoreline together with pelagic (water-column) production is providing an adequate amount of prey for the juvenile salmonids during their migration. Of the 259 stomachs sampled in East Waterway, only 4 percent were found to be empty. The characteristics of the proposed shoreline (in Segment F) would be similar to most of the existing East Waterway in that it would be steeply sloped and armored with a large riprap. Therefore, it is anticipated that the proposed shoreline will also provide an adequate amount of habitat for prey organisms consumed by juvenile salmonids migrating through East Waterway.

Segment F in the existing shoreline (Figure 5-1) provided habitat for relatively large quantities of juvenile Dungeness crab compared to other shoreline areas sampled in East Waterway and Port Gardner. The areas within Segment F where juvenile crabs were found included a muddy area at the north end of the segment and a muddy/sandy area with interspersed gravel and wood debris located at the south end of the segment. This type of habitat would be lost under the proposed shoreline which does not include any muddy/sandy areas. Based on the results of the juvenile crab sampling program that included comparisons of areas with and without cover, cover appears to be a key component for juvenile crab survival (Weitkamp et al., 1986). While juveniles would have some cover provided by the large riprap that would replace these muddy areas, it is not likely to provide habitat that is as good as that which currently exists. Therefore, a reduction in survival of juvenile crabs that settle-out in East Waterway may occur. However, this portion of the East Waterway is only a small part of the habitat available for juvenile crabs. The areas outside the East Waterway may have a lower density of larval crabs but are of much greater quantity overall. This much greater area outside the East Waterway would mean that changes inside the waterway are unlikely to affect juvenile crab rearing.

5.2 Dredge Site Impacts

Dredging of the East Waterway has been separated into three major projects. These are: 1) P-905, Outer Harbor Dredging, Second Increment; 2) P-111, Outer Harbor Dredging, Breakwater and Mole; and 3) P-112, Inner Harbor Dredging. The total amount of material, both contaminated and clean, to be removed under these three projects is estimated to be 3.305 million cubic yards. Removal of this amount of material is required to provide the necessary depths of -42, -50 and -55 ft MLLW for the naval vessels which would be using the harbor.

The degree and type of dredging impacts anticipated would depend upon the method employed for removal of material. Use of a barge-mounted clamshell dredge has been proposed for removal of surface debris and contaminated sediments. Hydraulic dredging or clamshell dredging with a pumpout barge has been proposed for removal of clean sediments.

5.2.1 Dungeness Crab

Dredging activities in the East Waterway will affect Dungeness crabs during the two year construction period. Both adult male crabs and juvenile crabs will be affected to some degree by the dredging activities for construction of the harbor facilities. Adult male crabs are apparently present in the East Waterway year round while juvenile crabs are present during the summer and early fall.

The effects both clamshell and hydraulic dredges have on adult Dungeness crabs have been studied by Stevens (1981). Crabs are affected by being picked up with dredged materials (entrainment) by both hydraulic and clamshell dredges. However, the entrainment rates for clamshell dredges is 4.9-6.6 percent of entrainment rates for hydraulic dredges. Stevens estimated that less than 10 percent of the crabs present in a dredge area suffer mortality due to clamshell dredging because very few crabs are captured in the dredge material. Both immediate and delayed mortality are much higher with hydraulic dredging which kills 56-100 percent of the crabs that are entrained. The portion of the crabs in the dredge area that are entrained by hydraulic dredging is uncertain; however, it is apparently a substantial portion of those present.

Clamshell dredges operate from a fixed position with intermittent grabs of bottom material. This mode of operation and the disturbance it causes apparently cause crabs to tend to leave the immediate vicinity of dredging. This results in low entrainment rates and low mortality rates for the clamshell dredging that will be used to remove contaminated sediments from the East Waterway.

Hydraulic dredging operations involve a continuously moving cutterhead having continuous suction. This mechanism entrains an uncertain but major portion of the crabs in the dredge area. In the East Waterway, hydraulic dredging will be used to remove clean material. This activity would be expected to kill most crabs present in the dredge area at the time hydraulic dredging occurs. Since hydraulic dredging will occur immediately following completion of the clamshell dredging during each of the two years, it is likely that the crab population of the dredge area will be reduced due to the disruption caused by the clamshell activity. The clamshell dredging will have removed the food sources that exist providing little to attract crabs back to the dredge area immediately following clamshell dredging.

Juvenile crabs in the East Waterway will also be affected by dredging. Weitkamp et. al. (1986) showed that substantial numbers of juvenile crabs are present in the East Waterway primarily during June and July. These young crabs are present in low numbers in August and September and absent by October. This trend indicates the young crabs either migrate rapidly out of the East Waterway or do not survive existing conditions in the East Waterway. Dredging is likely to destroy most of those young crabs present in the dredging area during the time of dredging. Approximately one third of the East Waterway would be dredged during each of the two years of construction. Thus, about one third of the young crabs produced by the East Waterway would be lost during each year. This impact is unlikely to produce a measurable impact, if any, on the crab population. Only about 40 percent of the dredge area will be dredged during the first year. This portion of the area should provide better than existing conditions by the second year when dredging will affect the remaining 60 percent of the area.

Both food sources (macroinvertebrates) and substrate (contamination) conditions should be improved following dredging. These changes provide an opportunity for increased production. However, existing substrate cover provided by bark will be lost with removal of contaminated sediments. The existing role of this bark and the reaccumulation of surface debris that may provide cover for young crabs is uncertain. Young crabs may be prevalent in the East Waterway in June and July because of bark accumulations on the bottom or perhaps only because they tend to accumulate in this embayment during their pelagic stage. Removal of contaminants is likely to provide better conditions for survival of those young crabs that do settle in the East Waterway.

5.2.2 Macroinvertebrates

The total area of the East Waterway that would be impacted by dredging operations is approximately 120 acres. This acreage represents the amount of existing benthic and epibenthic habitat

that would be disrupted and altered. Production from the dredge area would be temporarily lost during dredging operations. Few invertebrates (in terms of both species diversity and biomass) inhabit this area, apparently due to the existing contamination of the surface sediments. Average biomass from benthic samples collected in East Waterway was 16.2 g/M^2 compared to 61.1 g/m^2 from samples collected in Port Gardner. Also, the East Waterway samples were dominated more by polychaetes (75 percent of the total biomass was polychaetes) as compared to Port Gardner (50% of the total biomass). In the East Waterway, these polychaetes consisted primarily of the organism _Capitella capitata_.

For the few species and numbers of non-motile forms of benthic organisms presently inhabiting the East Waterway such as polychaetes, molluscs, and some crustaceans, impacts of both clamshell and hydraulic dredging would be similar. Disruption of bottom sediments by the clamshell bucket and subsequent loading into the dump barge would result in mortality for most of the benthic organisms in East Waterway.

Recolonization of the East Waterway following dredging should occur in a relatively short period of time. Recolonization times following dredging in other areas have been shown to be as rapid as 3 months (Swartz et al., 1980). Benthic macroinvertebrates, epibenthic crustacea, demersal and pelagic fish, and Dungeness crabs should recolonize the East Waterway rapidly by recruitment from the nearby large area of Port Gardner and the Snohomish River Delta. Recolonization of that portion of the area dredged during the first year is likely to provide production that exceeds existing conditions by 1987 before commencement of dredging of the second area during 1988.

Aquatic conditions in the East Waterway would be greatly improved on a short term basis following dredging as a result of the removal of contaminated sediments. Presently very few benthic macroinvertebrate species are able to exist in the East Waterway due to anoxic contaminated sediments (Appendix S, Navy FEIS). Improvement in benthic production,which includes higher species diversity, abundance, and biomass, would also improve production at higher trophic levels (e.g., crabs and demersal fish). The longevity of improvements to sediments and associated biota of the East Waterway as a result of removal of existing contaminated sediments would depend upon the nature and loading rates of future effluent discharges to the waterway.

5.2.3 Demersal Fish

Impacts on demersal fish from either clamshell or hydraulic dredging operations are not expected to be significant in the East Waterway. Most species encountered during baseline studies are highly motile and would avoid the area very soon after commencement of dredging operations (Appendix U, Navy FEIS).

Avoidance of the dredge related turbidity plume would negate potential impacts due to turbidity. Very few fish are expected to be destroyed by physical impact with the clamshell bucket or hydraulic cutter head. Some mortalities of demersal fish may occur through competition of fish displaced from the East Waterway to adjacent areas if the adjacent areas are saturated. Sufficient information is not available to accurately predict whether or not mortality associated with competition due to displacement would occur.

5.2.4 Salmonids

No dredging activity will occur during a fish window (March 15 to June 15) that has been designated by the Washington State Department of Fisheries to protect juvenile salmonids (salmon and trout). Studies conducted in East Waterway that monitored the temporal and spatial distribution of juvenile salmonids (Navy FEIS, Appendix C; Tulalip Tribes, 1986), indicate that they are still present after June 15. During the 1984 studies, the numbers of fish were substantially less, but some juvenile salmon (primarily chinook) were still present as late as July 10, the last day of sampling. The sampling conducted by the Tulalip Tribes in 1986 indicated juvenile chinook were in stable numbers in the marine waters of Port Susan, Everett Harbor and Possession Sound until July 25. In addition, the Navy is supporting ongoing research by the Tulalip Tribe to further evaluate the temporal distribution of juvenile salmonids in the project area. Preliminary results from their 1986 monitoring verified the presence of juvenile salmonids beyond June 15.

Those fish present beyond June 15 will be prone to dredging impacts that potentially include entrainment, reduced food, and increased turbidity. Entrainment impacts are likely to be minimized due to the pelagic nature of the juvenile salmonids. Also, by the time dredging begins (June 16 or later) they will have reached a sufficient size to avoid the majority of the impacts.

Some species of anadromous salmonids, searun cutthroat trout and to a lesser extent steelhead trout, have a life history cycle that includes the potential for juveniles to remain in the nearshore and estuary environments for extended periods of time. As a result, juvenile cutthroat may reside in the area beyond the June 15 fish window and be prone to dredging impacts. The salmonid monitoring program conducted during the spring of 1984 (Navy FEIS, Appendix C) did not collect any juvenile cutthroat trout. All cutthroat captured (82 total during the 4 1/2 month survey) were of sufficient size to avoid dredging impacts. In fact, the size range of cutthroat collected suggest that juvenile searun cutthroat are not rearing in the nearshore marine environment.

The March 15 to June 15 fish window is intended to protect juvenile salmonids. Adult salmonids (salmon and steelhead trout) are likely to avoid the turbidity plume associated with the dredging and not be impacted. In the case of the dredging operations scheduled for East Waterway it becomes a non-issue because adult salmonids are not known to migrate through East Waterway.

5.3 Disposal Site Impacts

5.3.1 Confined Aquatic Disposal

Confined aquatic disposal (CAD) involves several alternate sites each of which would have somewhat different impacts, but impacts on the same basic resources. For this reason the three CAD alternatives are discussed jointly. At each of the three sites the contaminated material would be released from bottom dump barges releasing the material at a single but different footprint area during each of the two years of dredging. A third footprint area would be affected by barge dumping of berm material. Barge positioning would be accomplished with sophisticated marine location equipment and regulated by contract requirements, unlike past routine dredging operations in Puget Sound. These requirements would ensure that the impacts of dredge disposal would remain within the limits discussed in this analysis.

The three CAD sites include Deep Delta CAD (DD CAD), Southwest Deep Delta CAD (SW CAD) and Revised Application Deep CAD (RAD CAD). These three sites differ primarily in their locations within Port Gardner and the bottom depths within each site. The DD CAD is located on a flat shelf at the toe of the Snohomish River Delta. Bottom elevations at the DD CAD site range from -240 ft to -320 ft within the 280 acre site. The DD CAD site is immediately southwest of the Snohomish River mouth. The SW CAD site is immediately downslope from the DD CAD site. The upper edge of SW CAD overlaps the lower edge of DD CAD. Bottom elevations of the 315 acre SW CAD site range from -300 ft to -370 ft. The RAD CAD site is further downslope and south of the DD CAD. The upper portion of RAD CAD overlaps the SW CAD site and meets the lower boundary of DD CAD. The bottom elevations of RAD CAD extend from -310 ft to -430 ft with an area of 380 acres included in the site.

The bottom substrate at each of the CAD sites is primarily soft clay and silt. According to grain size analyses conducted by Hart Crowser (1986) the grain size distribution of surface sediments at the CAD sites is very similar to the grain size distribution of clean materials to be dredged from the East Waterway. This more detailed analysis shows much greater similarity than the preliminary data presented by Anderson (1986) (See Hart-Crowser 1986, Figure 7). Unpublished PSDDA (U.S. Army Corps of Engineers, 1986d) data agrees with the grain size

analysis at the RAD CAD site showing about 85% silt and clay. These data show the RAD site to have about 5% total volatile solids in the surface sediments. The CAD sediments are gray to black in color and have a slight hydrogen sulfide odor. The surface of the CAD sites is covered with some debris as evidenced by the University of Washington trawl sampling (Dinnel 1986a, 1986b, 1986c, Appendix F).

Disposal of East Waterway sediments at the CAD sites would provide sediment characteristics little if any different following disposal as compared to existing conditions. The 4.5 ft thick cap of clean material (average) would provide a suitable substrate for recolonization by benthic organisms of the same species that currently inhabit the site. According to the WES studies (U.S. Army Corps of Engineers, 1986a) a one ft cap will isolate the chemical contaminants from the overlying environment. The similarity of grain size and the isolation of contaminants would provide an opportunity for rapid recolonization by benthic organisms.

Placement of the contaminated material would be by bottom dump barges having a 2000-4000 cu yd capacity. Each release from the barge would cover an area of 600-800 ft by 800-1000 ft depending on the barge capacity. The mound immediately beneath the barge would be a maximum of 0.26 ft thick within several minutes of the time the material reaches the bottom. Clean material would be placed on top of the contaminated material during each of the two years of dredging. The clean material would be dredged by hydraulic dredge and pumped to the CAD site where it would be released from a downpipe continuously during dredging of the clean material for a 6-12 week period. A clamshell dredge and pumpout barge might be used and would have the same effect as the hydraulic dredge. Capping with the clean material would begin immediately following completion of the contaminated material dredging during each of the two years. Clean material will accumulate on the site within a 250 ft radius (4.5 acres) at a mean rate of 2-3 inches per hour with a maximum rate of 6 inches per hour at the center of the 250 ft radius. The downpipe will be moved approximately every 3-4 hours to give a maximum accumulation of up to 4 ft in one day at the center of each 250 ft radius. Design criteria are such that the support strength of the contaminated sediments after consolidation will withstand more than 4 ft of bulked capping sediments (in slurry).

Turbidity in the water column would occur during disposal of dredge material. Studies have shown that turbidity would be short term with bottom dump barge disposal due to sediment characteristics and current patterns (Appendix B, DEISS). The dredged sediment is primarily clay and silt, which is very cohesive even when descending in water. At 30 minutes after disposal no more than 1.9 percent of the material would remain in suspension. The amount of sediment in suspension after 60

minutes is equivalent to 12 to 18 ppm. However, current velocities at or near the surface and at midwater depths would serve to dissipate the turbidity plume. The large body of water in which the sediment is disposed would offer a high dilution factor, as well.

Cap thickness is critical for isolating contaminated material from the surrounding environment. A thickness of 1 ft has been determined to be sufficient to prevent migration of contaminants through the capping material into the overlying water (U.S. Army Corps of Engineers, 1986). However, a cap thickness of 80 centimeters has been recommended to virtually preclude bioturbation by very deep burrowing organisms, such as geoducks, which could expose contaminated sediments to the environment if they were present. The proposed cap would have a minimum thickness of 3.3 ft (1 meter) following consolidation and settling.

5.3.1.1 Dungeness Crab

Studies of both adult and juvenile crabs inhabiting the dredge area (East Waterway) and CAD disposal sites (Port Gardner) have been conducted to define the resource that may be affected by dredging and disposal. These studies include a year long sampling of the East Waterway and adjacent areas (Weitkamp et al. 1986) and four seasonal samplings of adult crabs in Port Gardner (Dinnel et al. 1986a, 1986b, 1986c, Appendix F).

Weitkamp et. al. (1986) found that substantial numbers of young of the year crabs do settle in the dredge area following their approximately three month pelagic period. These juveniles are present for only about two months (June-August) in substantial numbers. In the East Waterway the young crabs either migrate from the area by August-September or suffer mortality. Juvenile crabs also occur in Port Gardner outside the East Waterway in shallow water areas but at densities lower than inside the East Waterway. There is no evidence that juvenile crabs are present in deepwater portions of Puget Sound. They are also not generally pelagic during the time of the dredge disposal activities July - November. Thus it is unlikely that disposal activities at the CAD sites would have any detectable impact on juvenile Dungeness crab.

Dredging operations will not occur during the period from March 15 to June 15. Therefore, during early larval development, no disposal will occur. In late June and July, when dredging and disposal operations commence, there is the potential for some overlap with the time when crab larvae may be present. However, this late in their development they tend to be surface oriented in the water column and located along the shoreline where they typically settle out during June and July.

The distribution of adult crabs has been studied by Weitkamp et al. (1986) in shallow areas and Dinnel et al. (1986a, 1986b, 1986c, Appendix F) in both shallow and deep areas of Port Gardner. Both of these studies have found that the shallow water areas of Port Gardner are inhabited primarily by male Dungeness crab and relatively few female Dungeness crab, although Weitkamp et al. (Table 4) found the ratio of females to males to be very high on the shallow portions of the Snohomish River Delta (0 to 10 ft) that were not sampled by Dinnel et al. However, Dinnel et al. found the ratio of females to males to be low in shallow subtidal areas (-33 ft to -131 ft) of Port Gardner and high in deep subtidal areas (-131 ft to -328 ft).

The depth distribution of adult male crabs is primarily in shallow subtidal portions of Port Gardner. Dinnel et al. found the greatest densities of male crabs to occur at depths of -33 to -131 ft. They collected no samples shallower than -33 ft and did find male Dungeness in small numbers as deep as -262 ft. Weitkamp et al. found male crabs in moderate numbers 19-137 per hectare on the periphery of the Snohomish River Delta in shallower areas than those sampled by Dinnel et al.

The distribution of female crabs is quite different from that of male crabs. In sampling Port Gardner at depths of -33 to -656 ft, Dinnel et al. (1986a, 1986b, 1986c, Appendix F) found that during each of four seasons sampled female crabs were concentrated primarily in areas that are between -33 ft and -262 ft with some females as deep as -525 ft. The greatest concentrations of females below -33 ft occurred near depths of -131 to -262 ft. During the four seasons that were sampled, concentrations of females ranged from 19 to 918 per hectare between depths of -131 and -262 ft. At least one additional concentration of female crabs occurs above 33 ft deep. Weitkamp et al. (1986) found high numbers of crabs at a shallow water station (0-10 ft) on the Snohomish River Delta. In 13 samples collected over a 12 month period at a single station they found densities of 20-588 female Dungeness per hectare with a mean density of 154 females/hectare. These data indicate there is at least one concentration of female crabs in very shallow water in the Port Gardner area.

In general the distribution of female crabs is patchy. The greatest concentrations occur within the depths described above along the periphery of the Snohomish River delta particularly in the vicinity of the Snohomish River mouth. Lower concentrations of females occur at the same depths along the southeastern Port Gardner shoreline.

One of the highest concentrations of female crabs has been found in the immediate vicinity of the three CAD sites. This concentration is located on the 260 ft deep flat area that forms the upper portion of DD CAD. This concentration of females has been responsible for the development of the SW CAD and RAD CAD

alternative sites. Figures 5-2, 5-3, 5-4 and 5-5 show the distribution of female crabs in Port Gardner during three seasonal surveys and the location of proposed disposal sites in relation to these data. The densities of both male and female Dungeness in the Port Gardner area are the highest observed to date in any of the portions of Puget Sound sampled.

The potential impacts to the Dungeness crabs, and particularly female crabs are described below. The SW CAD site would reduce exposure of that concentration of females that exists toward the upper edge of the DD CAD by restricting placement of dredged material to depths greater than 300 ft. This location avoids the concentration of crabs in the upper portion of DD CAD in -262 ft of water. The SW CAD site does not totally avoid female crabs as some females (0-75/hectare) occur in the lower portion of the DD CAD that would be included in the SW CAD. The RAD CAD site was selected at Figure 5-2 greater depths to further remove the disposal from the concentration of females at the upper end of the DD CAD site. The RAD CAD site extends from -310 ft to -430 ft deep in an area having few female crabs (0-38/hectare). Figures 5-2, 5-3, 5-4 and 5-5 show the numbers of female crabs found at and near the three alternative CAD sites as well as the existing Port Gardner disposal site.

Impacts to crabs inhabiting each of the three CAD sites might occur in either the short term and/or the long term. Short term impacts would be those having an immediate effect, but no measurable lasting effects on the crab population. Long term impacts would be those having an effect for an extended period of time (many generations). The immediate impacts that might be expected include burial, physical injury or death caused by large clumped materials striking crabs. Other impacts that may be as severe, but do not occur immediately include stress associated with water quality degradation that may kill individual crabs as well as reduced reproductive capacity resulting from exposure of crab eggs or larvae to contaminated sediments. The long term impact that might occur would be habitat alteration which could make the site less suitable as Dungeness crab habitat.

The potential for impacts on crabs due to burial would be determined by the rate of material accumulation and the thickness of material deposited within short periods of time. These variables are different for barge release of the contaminated material and downpipe release of the cap material. Modelling studies of the barge release indicated the average thickness in a 200 x 200 ft grid immediately below the barge will be 2-3 inches per dump with a maximum unconsolidated depth of about 6 inches (Appendix B of the DEISS). The thickness of material in locations away from this grid will gradually decrease to zero. The effect of burial on Dungeness crab has been addressed in a single study (Chang and Levings, 1978). This research, was conducted in British Columbia using male crabs. Recognizing that the crab

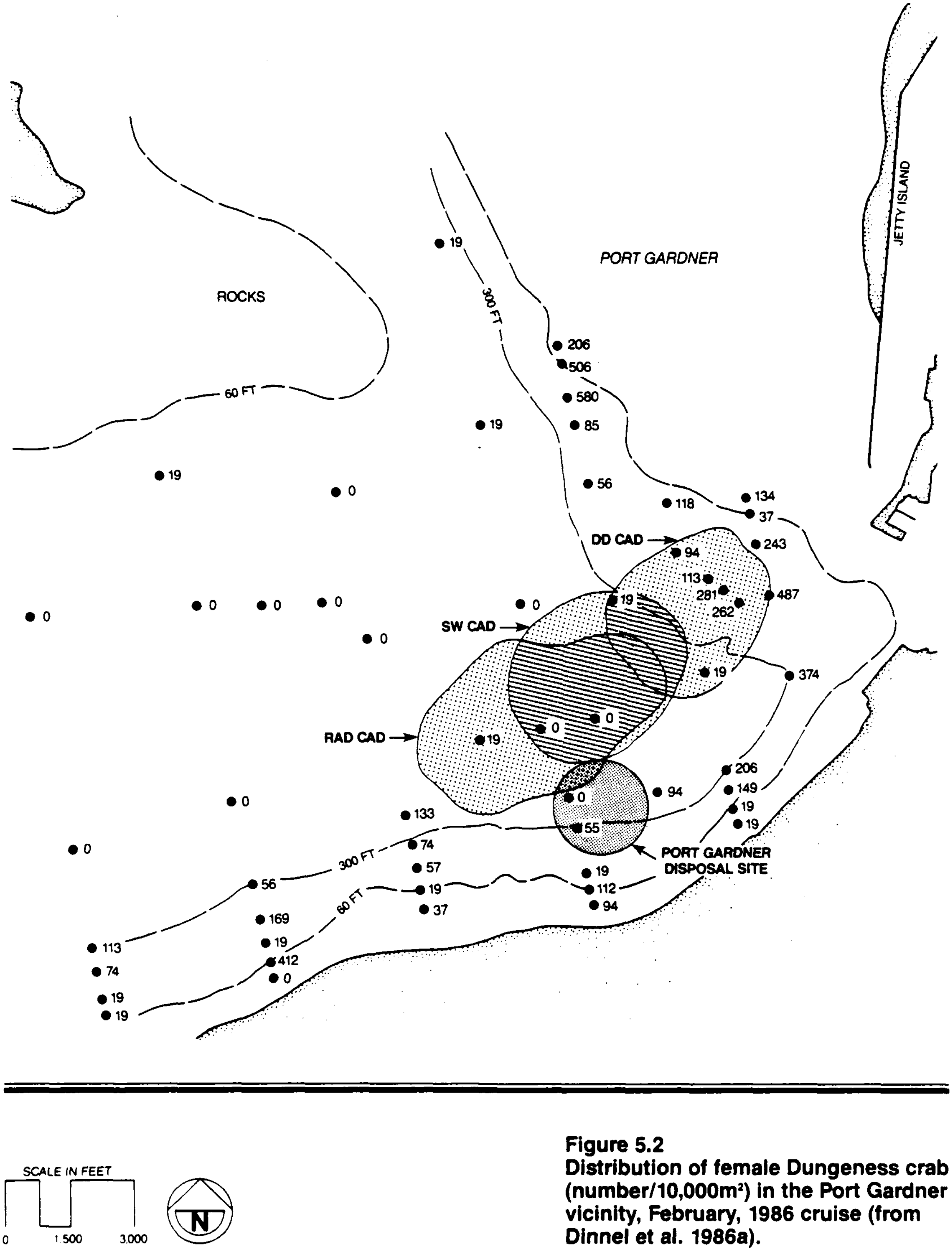


Figure 5.2
Distribution of female Dungeness crab (number/10,000m²) in the Port Gardner vicinity, February, 1986 cruise (from Dinnel et al. 1986a).

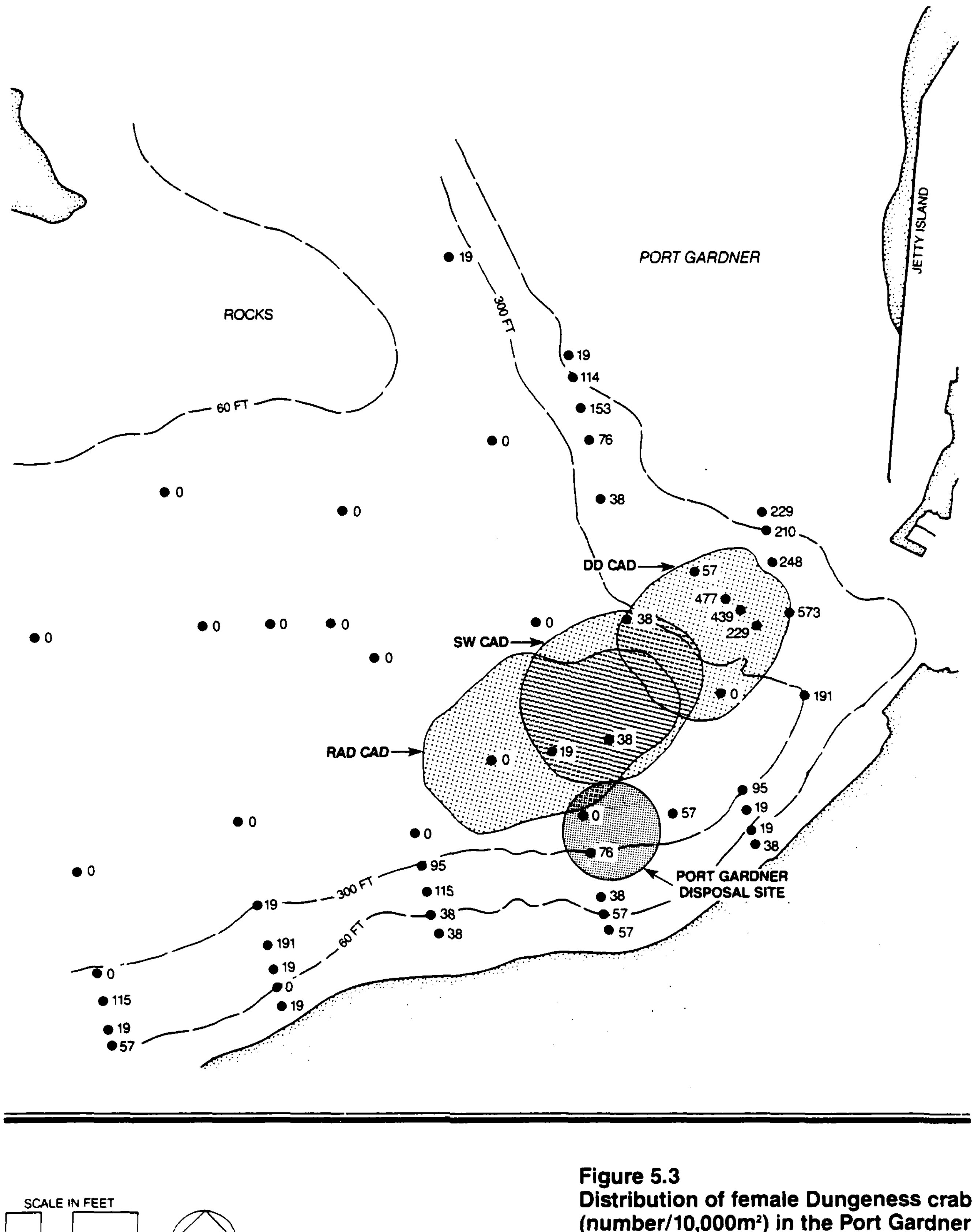
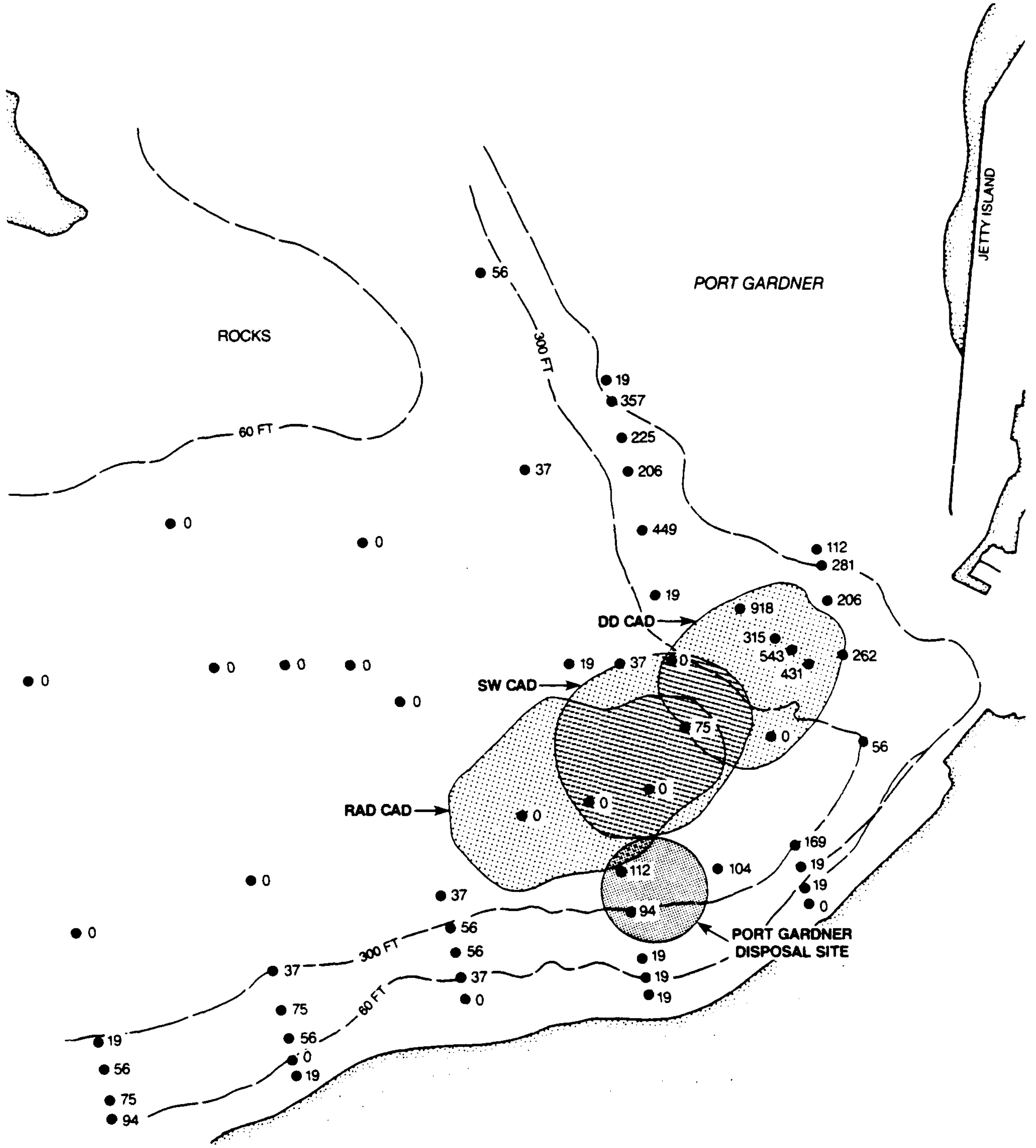


Figure 5.3
Distribution of female Dungeness crab (number/10,000m²) in the Port Gardner vicinity, April, 1986 cruise (from Dinnel et al. 1986b).



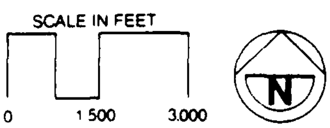


Figure 5.4
Distribution of female Dungeness crab (number/10,000m²) in the Port Gardner vicinity, June, 1986 cruise (from Dinnel et al. 1986c).

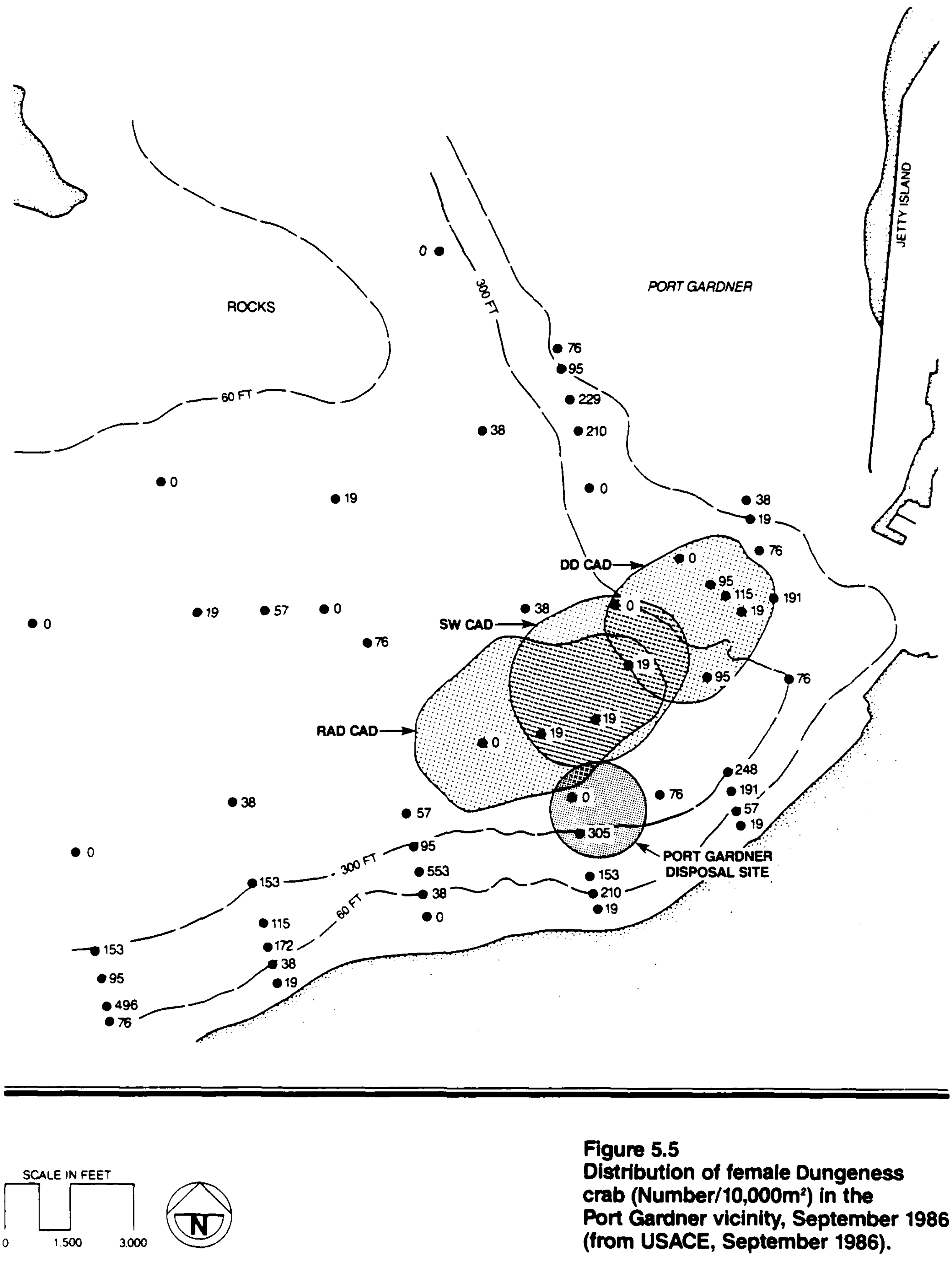


Figure 5.5
Distribution of female Dungeness crab (Number/10,000m²) in the Port Gardner vicinity, September 1986 (from USACE, September 1986).

resource is predominantly female on the CAD site, this research was relied upon for several reasons. It is the only published information available that deals with burial of Dungeness crab. Except for their ovigerous life stage, the physical structure of males and females is nearly identical except the females tend to be smaller at the same age. As discussed later, disposal of contaminated material will not occur during the ovigerous life stage.

Chang and Levings (1978) indicated that crabs could successfully dig out after burial from 4 inches of sand, but were not able to dig out when buried by 8 inches of sand. Their experimental design was not intended to identify a critical depth of burial (i.e. increments between 4 and 8 inches were not tested). Based on these results, impacts due to burial from a single dump from a barge should not kill Dungeness crabs by burial. However, a conservative approach would suggest that some crabs, perhaps females, could suffer mortalities from a 6 inch covering.

Releases of the contaminated material will increase the thickness of material deposited in a 200 x 200 ft grid by increments of about from 2-3 inches as predicted in the single dump model. This is less for an individual release than the 4 inches cited by Chang and Levings. However, their research indicated that 80 percent of the crabs buried in 4 inches escaped within 6 hours. The remaining 20 percent escaped within 24 hours, the next time increment sampled. The rate of dumps scheduled would be about 3 barges per two days in FY 1987 (approximately every 16 hours) and 5 barges per two days in FY 1988 (approximately every 9.5 hours). Given the crabs' ability to dig out within 6 hours, these dump rates should not cause significant burial impacts as a result of successive dumps due to increased thickness. However, a portion of the crabs (less than 20 percent) located directly below the barge dump that are not able to dig out within 16 hours in FY 1987 or 9.5 hours in FY 1988 may be susceptible to burial by repetitive dumps. No information is available on the effects of repetitive dumps on individual crabs. Since the material would accumulate slowly away from the release site those crabs in other portions of the CAD sites should be able to escape burial.

Cap material will be released from a submerged downpipe either from a hydraulic dredge or pumpout barge. A complete description of the capping process is provided in Sections 3.5.1.2 and 3.6.1.1 - Sediment Removal. This technique will result in a steady "rain" of material being deposited over a 250 ft radius within the site. The application of this material will occur 24 hours per day, 6 days per week with the downpipe moved about every 3-4 hours. Given that rate, model predictions indicate the maximum accumulation in any one 250 ft radius would be up to 4 ft. Observations made during Chang and Levings' research indicated that male crabs would dig out during the deposition as opposed to waiting until deposition ceased. Organisms in general

do not remain in steadily increasing life threatening situations such as slow burial would cause. Because crabs must maintain contact with overlying waters to meet respiratory requirements, it is logical to assume that they would not permit slow burial to occur. It is also unlikely that major concentrations of crabs would accumulate on the recently placed contaminated materials that would offer no food sources. Therefore, physical burial impacts due to placement of the cap material are not expected to be significant. This impact analysis is based only on male crab data. Similar information on female crab behavior is not available. The assumption is that for purposes of this analysis, female behavior is expected to be similar during the non-egg bearing stage of their life cycle.

In addition to the physical burial potential associated with disposal, impacts due to the stress associated with disposal might occur. This stress may occur as a result of degradation of sediment/water quality due to the anaerobic condition of the sediments to be deposited. Although some aeration of sediment may occur during disposal, BOD and COD associated with both the contaminated and the cap material may add to the stress experienced by crabs during the disposal operation. This additional level of stress may decrease the crab's ability to dig out. However, no data are available to quantify the effect this additional stress may have on crab impacts.

Physical injury due to individuals being struck by large clumps of sediment having sufficient cohesiveness to physically damage their shell may occur. This impact is possible for only a portion of the population inhabiting the site. All discharge of contaminated materials from barges would occur along one of three footprint areas in both the FY 1987 and FY 1988 disposal operations. Only those crabs directly under the drop are likely to suffer either of these possible impacts. Insufficient information is available to accurately define the percentage of crabs susceptible to this impact. We assume that as a conservative estimate, only those crabs in the disposal drop zone would be susceptible to this injury. Within the drop zone, crabs would be susceptible to physical trauma from large clumps or heavy objects (bark, debris, etc.). The drop zone would be limited to the area immediately beneath the barge that would be placed along one of the three baselines for each of the release. The baseline drop zones would be about 34 acres (13.8 hectares) for the berm, about 34 acres (13.8 hectares) for the FY 1987 contaminated material and about 30 acres (12.1 hectares) for the FY 1988 contaminated material. The berm and FY 1987 impacts would occur during 1987 while the FY 1988 impacts would occur during 1988. The drop zones are about 20 percent of each of the CAD sites in 1987 and 10 percent of each set of the sites in 1988. Thus about 20 percent of the crabs on a CAD site would be at risk to this injury during 1987 and 10 percent during 1988. This analysis

assumes there would be no significant migration into or out of the drop zone during disposal operations.

The Dungeness crab population inhabiting the CAD sites and similar areas of Port Gardner is primarily female crabs with the male crabs being found in shallower water. Population estimates have been made for each of the three CAD sites using June, September and February data from Dinnel et. al. (1986c, Appendix F, 1986a). These are the available data for the proposed dredging period. The April data were not used because no dredge disposal will occur during that period as a result of the fish window (March 15 - June 15). All samples collected in each site were combined to provide a mean density for each site during each sampling period. The DD CAD had estimated female Dungeness populations of 8,900 to 39,800 during these three sampling efforts. The SW CAD had estimated female populations of 800 to 2,400 and the RAD CAD had estimated populations of 900 to 2,900 female crabs.

In a conservative analysis of disposal impacts it is assumed that all crabs at risk are in the drop zone. In the DD CAD site an estimated 350 female Dungeness would be in the berm drop zone and 8,170 females in the FY 1987 drop zone. An estimated 7,200 female crabs would be in the FY 1988 drop zone. This analysis is based on the mean of the maximum numbers (June) of females observed on the DD CAD site. The same analysis indicates that the SW CAD site would have 350 females in the berm drop zone, 350 in the FY 1987 drop zone and 300 in the FY 1988 drop zone. The RAD CAD site would have similar numbers of female Dungeness crabs with 260 in the berm drop zone, 260 in the FY 1987 drop zone and 830 in the RAD CAD drop zone based on the maximum densities in April. This conservative analysis indicates that 15,700 female crabs would be lost at DD CAD, 990 at SW CAD and 830 at RAD CAD as the result of placement of the berm and contaminated material.

Cap material will be placed continuously 24 hours per day, 6 days per week during the dredging of clean material. This material will not contain clumps because of the hydraulic dredge action and it will contain little debris. Therefore physical trauma to crabs due to placement of this material is unlikely. This material will accumulate slowly over a 30-40 hour period at any particular location on any of the three CAD sites. This slow accumulation is less likely to result in burial of crabs. All injured or stressed crabs are assumed to have died prior to this time. It is likely that most crabs would have been either displaced from the fill area or killed by the disposal of contaminated material that would immediately precede capping with the clean material.

Migration of crabs onto the fill area immediately following placement of the contaminated material is unlikely due to the contaminated nature of the substrate and the low abundance of

food organisms in this material. Benthic samples collected in East Waterway had a much lower biomass (16.2 g/m^2) compared to other areas of Pt. Gardner (61.1 g/m^2). Also, the abundance of adult crabs in East Waterway was lower than other areas of Port Gardner (Weitkamp et al., 1986). This indicates that the habitat characteristics there, which include contaminated sediments and low benthic biomass, are not as attractive to adult crabs as other areas of Pt. Gardner. Predicting whether or not crabs will migrate into the disposal area during dumping of sediments is somewhat speculative because there is not any scientific literature that specifically addresses the migration issue with adult Dungeness crab and contaminated sediments. However, based on the existing conditions of East Waterway it does not seem likely that the sediments will serve as an attractant to crabs during disposal. The clean cap material will be primarily deeper material from the East Waterway that will not have biological organisms that could be attractive to crabs in the freshly placed cap. Thus placement of the clean cap material is unlikely to directly kill crabs in the same manner that placement of the contaminated material and berm material would under the conservative analysis.

An additional impact could be caused by an impairment of the crabs' reproductive capacity. The project has been specifically designed to avoid the possible impact of toxic impairment of the crabs' reproductive capacity. Contaminated materials would be placed at the selected CAD site during the summer and early fall of each of the two years of construction. Female crabs do not commonly bear eggs during this period. The contaminated material (except for potential minor losses) would be covered with a cap of uncontaminated material by early September in 1987 and by early October in 1988, preventing exposure of the egg bearing females to contaminated dredge materials. The thickness of the cap material (4.5 ft average consolidated) is designed to isolate the contaminated material from organisms that burrow much deeper than Dungeness crabs, most notably the geoduck clam. The potential loss of any or all of the crabs inhabiting the CAD site should be considered in light of the total crab population. The crabs on the DD CAD site are a significant portion of a larger population that inhabits Port Gardner. The area in Port Gardner between -66 ft and -328 ft (the area of greatest female crab distribution) is at least 1,500 acres. The 1,500 acres includes only the portion of Port Gardner that was sampled by Dinnel et. al. (1986a, 1986b, 1986c). As shown by Weitkamp et al. (1986) concentrations of female Dungeness do occur outside this 1500 acres. The area of the DD CAD site that falls above the -328 ft depth contour is about 150 acres, or about 10 percent of the total area in Port Gardner. By contrast, about 20 acres of the RAD CAD are located above -328 feet, or about 1.5 percent of the total area in Port Gardner. The Port Gardner population is unlikely to be isolated from the adjacent populations of Port Susan and central Puget Sound. The demonstrated migratory habits

of the Dungeness crab and the prolonged (3 month) pelagic phase of crab larval stages provides opportunity for intermixing of adjacent groups in most situations.

These considerations together with the great reproductive capacity of Dungeness crabs and the natural population fluctuations imply that any short term impacts to the crabs inhabiting the DD CAD site most likely would not result in any long term changes to this group or impacts to Dungeness crabs outside of Port Gardner.

The lower density of female Dungeness at the SW CAD and RAD CAD sites would provide a lower probability of a short term impact to crabs than would the DD CAD. According to the conservative analysis, less than 1000 crabs are likely to be destroyed at each of these sites.

Long term impacts could result from potential habitat changes at each of the three CAD sites. It is theoretically possible that the disposal of East Waterway sediments at the CAD sites could sufficiently alter the physical characteristics of the sites to provide less or no suitable habitat for Dungeness crabs (females). Since the characteristics of good habitat for females have not been defined, it is necessary to assess those measurable characteristics of the area within Port Gardner that is known to used by these females.

Female crabs within Port Gardner appear to be distributed primarily within a preferable depth range. Most of this preferred range extends from -131 ft to -328 ft with the greatest concentrations near -262 ft. However, some obviously select the shallower periphery of the delta. The distribution of egg-bearing females within these depths is patchy, indicating that more than depth is important to the crabs in selecting preferred habitat. It appears that most of the slope of Port Gardner near -262 ft, but especially at the Snohomish River mouth offers preferred habitat, as does at least one shallow portion of the delta.

Table 5-2 identifies other possible characteristics that might be important to the females in selecting preferred habitat. Of these parameters, there are several that could be altered at each of the CAD sites. The elevation of the site would be increased by disposal of the dredged material; however, the change would be small in comparison to total water depth and would remain within the apparently preferred range of the females. The slope of the site would be altered slightly at each of the CAD sites. The slope at DD CAD would decrease from the existing 30:1-50:1 to a slightly flatter range of 50:1-100:1. The slopes at SW CAD and RAD CAD would decrease from about 35:1 - 50:1 to near 100:1. The placement of the cap material by hydraulic dredge or pumpout barge would provide a smooth surface with gradual slopes very

similar to these of the existing site. Debris (wood and trash) presently on the surface of the CAD sites and other Port Gardner areas, which may provide scavenging habitat for crabs, would be covered by this dredged material. Natural processes will allow debris to accumulate at the site over time. There is no indication that this debris is important to crabs.

Table 5-2. Known characteristics of Port Gardner bottom areas that are likely to influence suitability of Dungeness crab habitat.

	APPARENT HABITAT CHARACTERISTICS		
Parameter	Existing Site	After CAD	Adjacent Crab Areas
Water Depth			
DD CAD	Mean 290 ft	Mean 260 ft	Mean 262 ft
SW CAD	Mean 340 ft	Mean 310 ft	Mean 262 ft
RAD CAD	Mean 320 ft	Mean 340 ft	Mean 262 ft
Overlying Water (all sites)	Port Gardner salinity, temp., etc.	Same	Same
Proximity to Snohomish R. Delta			
DD CAD	1,000 yds	1,000 yds	500-10,000 yds
SW CAD			
RAD CAD			
Slope			
DD CAD	30:1-50:1	50:1-100:1	20:1-100:1
SW CAD	50:1	100:1	20:1-100:1
RAD CAD	50:1	100:1	20:1-100:1
Substrate Grain Size (all sites)	Port Gardner deep sediments	Same[A]	Assume Same
Physiochemical Composition (all sites)	uncontaminated H_2S under surface	uncontaminated H_2S under surface	Assume Same

[A] Hart-Crowser 1986; U.S. Army Corps of Engineers, 1986a, 1986d.

The major change possible at the site is an alteration of substrate characteristics. Both grain size and the physicochemical composition of the sediments can be altered at each of the CAD

sites. The toxicants present in the contaminated material from the East Waterway might sufficiently alter the site to make it unsuitable for egg-bearing female crabs. The project would avoid this impact by placing a cap of uncontaminated material over the contaminated material. Studies by WES (Appendix D of the DEISS) have demonstrated that a cap one foot thick (30 centimeters) is sufficient to isolate the chemical contaminants from the overlying environment. However, a cap 2.6 ft thick (80 centimeters) would be necessary to further isolate the contaminated material from deep burrowing organisms. A 3.3 ft (1 meter) or greater cap thickness is given as an minimum operational requirement to allow for some irregularities in cap thickness without violating the 2.6 ft requirement. The project design will provide an average cap of 4.5 ft thick to isolate the contaminants from the egg-bearing female crabs that burrow no more than 4-6 inches into the sediment. Thus, providing the disposal site meets design criteria there will be no exposure of egg bearing females to contaminated sediments as a result of burrowing.

The proposed cap material is similar to the existing surface sediments at each of the CAD sites. Both sediments have probably been produced by a combination of Snohomish River sediments and near-shore Puget Sound sedimentation. The grain size distribution of the existing sediment at DD CAD and the cap material are very similar (Hart-Crowser 1986). The Hart-Crowser data showed a much greater similarity than preliminary data provided by Anderson and Crecelius (1985). The grain size characteristics of existing sediments at RAD CAD are also similar to the cap material (U.S. Army Corps of Engineers, 1986a, 1986d). Three stations sampled for PSDDA studies are within the confines of the RAD CAD. These three stations had percent fines that ranged from 72-85 percent. The cap material has percent fines that range between 50 and 90 percent (Hart-Crowser, 1986). The cap surface would become similar to the existing sediment surface within a short period as a result of the same biological and physical activities that cause the existing conditions. The use of a cap and the selection of nearby sediments for capping that are identical to the existing sediments would avoid predictable substrate changes that are likely to alter the habitat value of the existing site to egg-bearing females. There is no guarantee that this material will provide habitat of value equal to that of the existing sites. There is no indication that it will not provide equally valuable habitat.

Initially the cap material would be devoid of benthic and epibenthic organisms that provide a food source for crabs. These organisms can be expected to begin to recolonize the cap within weeks after the cap is in place. Based on experience with past dredge and fill sites, within one year the fauna can be expected to be similar to the fauna of the existing and surrounding substrate, although several years may pass before all invertebrate populations reach stable levels. Therefore, the delay in

recolonization may affect the use of the site by female crabs during the first year following disposal. This impact would occur following both the FY 1987 and FY 1988 disposal operations. Some recolonization of the FY 1987 fill will have occurred by 1988 but will be destroyed by the FY 1988 operations.

Evidence that tends to support this assessment is provided by the existing Dredge Disposal Site in Port Gardner. This site has received periodic disposal of dredged material that has likely altered the grain size of the sediments. Even though no attempts were made to match grain size, two of three crab samples (Transect 7, station 100S; Transect 2, stations 80S and 110S) showed egg-bearing females inhabit the edges of the existing disposal site (Dinnel, et al. 1986a, 1986b, 1986c, and Appendix F). No crab samples have been taken from the center of the existing Port Gardner site.

5.3.1.2 Macroinvertebrates

Direct loss of benthic macroinvertebrates would occur at each of the three CAD sites due to smothering by disposal of dredge material. Benthos are relatively non-motile and would not be able to escape burial. Macroinvertebrates would also not be able to burrow up through deposited sediments greater than several inches thick because the rates of deposition are likely to be too rapid. Virtually all benthic macroinvertebrates on either of the three CAD sites would be lost during disposal operations.

Recolonization by benthos is expected to occur rapidly after completion of dredge material disposal and capping. Recovery times for marine macroinvertebrates have been shown to be short, in one case at a different site only 3 months was required for complete recovery following dredging (Swartz et al., 1980). It should be noted, however, that the conditions monitored in Swartz's study are not necessarily the same as those at RAD CAD. It is expected that recovery of the FY 1987 area would be well along prior to the FY 1988 disposal. No more than two thirds of a CAD site would be affected in 1987 although all of the site will be affected in 1988. The area surrounding the CAD site is very large and productive. A high rate of recruitment from the surrounding areas is expected, which would minimize the recovery time of any of the three CAD sites following completion of dredge disposal operations.

The placement of clean capping material with grain size characteristics similar to those of the existing sediments would help to ensure successful recolonization of any of the three CAD sites. Data from Hart Crowser (1986) and the U.S. Army Corps of Engineers (1986a, 1986d) indicate that the capping material does have similar grain size characteristics as the existing sediment at DD CAD and RAD CAD, respectively. Marine benthos have preferred substrate characteristics and any alteration of

sediment composition can have dramatic effects on community structure (Pearson and Rosenberg, 1978). By matching pre-disposal conditions, long term impacts on the benthic community would be prevented.

Results of the Hart Crowser grain size comparison conflict with an earlier comparison made by Anderson and Crecelius (1985). Hart Crowser's comparison was designed specifically to address cap material composition in comparison to existing conditions at the DD CAD site. Therefore, we have used their results in assessing impacts.

5.3.1.3 Demersal Fish

No significant direct losses of demersal fish would occur at the CAD site due to the disposal of dredge sediments. A single barge load would cover a portion of the disposal site with sediment to a thickness of 2 to 3 inches. Flatfish often bury themselves in soft substrate for camouflage and would have no difficulty digging out of only 2-3 inches of sediment. Pelagic fish such as hake, pollock and cod are likely to feel the descending pressure wave created in front of the material via their lateral line system (Smith, 1982) and move away from the area. Most demersal fish are also likely to feel the descending sediments and would be able to move out from under the sediment before it contacts the bottom. There is, however, likely to be a few buried bottom fish (flatfish) that will get struck with "clumped" material or be buried too deep for escapement. The magnitude of this unavoidable impact is not known, but is expected to be minimal.

Turbidity associated with hydraulic dredge disposal would be continuous during dredging operation. Initial reaction by both pelagic and demersal fish to dredge disposal is likely to be migration out of the area. As disposal continues fish are likely to avoid the turbidity plume thereby preventing any direct impact on the fish such as suffocation. The absence of many benthic organisms in the material to be dredged should prevent the disposal site from providing an attraction to fish that might prey on organisms present in this material. The biomass of benthos collected in the East Waterway averaged 16.2 g/m^2. This is low compared to adjacent areas such as Port Gardner where samples collected indicated the average biomass was 61.1 g/m^2. Also, after the dredging operations have removed the upper one foot of material, the presence of benthic organisms is likely to decrease drastically.

If fish are attracted to the disposal site they would be exposed to contaminated sediments for a short period of time. According to the dredging schedule, a conservative estimate of exposure time to contaminated sediments is 35 days in FY 1987 and 55 days in FY 1988. These estimates are based on elapsed time from the first dump of contaminated sediments to the final placement of

the first layer of capped material. Whether or not exposure during these time periods would cause chronic impacts is only speculative.

The major impact on demersal fish will be the smothering of macrobenthos, which is a primary food source and disruption of their habitat. Most fish inhabiting the CAD site would migrate away from the area due to physical disruption from sediment disposal and lack of food. This in turn could cause indirect impacts through competition occurring in other areas where the fish are displaced. Data are not available to determine if the carrying capacity of the Snohomish River delta vicinity is currently saturated, or whether it can tolerate an increase in some areas. However, given the productive nature of the delta, and the fact that displacement will be temporary, it is not likely the displacement will cause major impacts. As discussed in the previous section (Macroinvertebrates 5.3.1.2), the benthic community will likely recolonize the area quickly, providing a food source for the demersal population and reducing the displacement pressure in other areas of the delta.

The demersal fish resource at greatest risk of suffering impacts is the Pacific hake. Results of the University of Washington's Homeport Disposal Site Investigations (Dinnel et al. 1986c) indicate that the area of Port Gardner which includes the DD and portions of the SW CAD site may be a hake nursery ground. This conclusion is based on the fact that large numbers of juvenile hake (young of the year) were present during their April and June cruises, while adults were virtually absent. Hake were in significantly lower numbers and biomass at the RAD CAD site compared to the SW and DD CAD sites. The trend for lower biomass at the RAD CAD site was true for bottomfish in general during all four sampling seasons (Dinnel et al. 1986a, 1986b, 1986c, and Appendix F).

Use of this area as a nursery ground means that disturbance or disruption during a critical growth period could cause more severe impacts than disposal during a less critical life stage. Many of the measures taken to minimize disposal impacts in general will also minimize impacts to juvenile hake. Moving the site to a deeper location (RAD CAD) will likely decrease the numbers of hake exposed to impacts. Timing of the disposal operation will also minimize impacts. Juvenile hake were present in April and June, a period when no disposal will occur due to the fish window (March 15 to June 15). Also, disposal operations will cease by late fall in both years allowing a 4-6 month period of stabilization and recolonization before April, the time when juvenile hake become abundant.

5.3.2 Snohomish River Channel Site

The Snohomish River Channel Disposal Site encompasses approximately 180 acres of intertidal habitat in the Snohomish River. Approximately 155 acres of the site would be covered by disposal of dredge material. Disposal of contaminated material at the site would reach an elevation of +7 feet MLLW, and the addition of uncontaminated material would extend the elevation to +23 feet MLLW. The site has the capacity to contain the total amount of material to be dredged from the East Waterway. If the site contained only the contaminated material, with the clean material going to an unconfined open water site, then only 100 acres of the site would be covered. Impacts associated with unconfined open water disposal would also have to be considered.

5.3.2.1 Aquatic Fauna

No site specific biological data were collected from the Snohomish Channel site for Homeport Project Impact Assessment. Therefore, the impacts described herein are based on existing studies conducted for other purposes. The Snohomish River Channel Site is currently being used as a log rafting/storage area. Limited data exist on the benthic and epibenthic communities present at the site. Samples collected from the high tidal elevations (+5 to +8.5 MLLW) indicated that preferred juvenile salmonid prey organisms found elsewhere on the Snohomish estuary mudflats are not present at this site (City of Everett, 1980; Smith, 1977). However, no information is available on the epibenthic communities present in the area of the site to be utilized for disposal (-2 to -5 MLLW). Even if this area were similar to the higher elevations (which did not support juvenile salmonid prey organisms), it has the potential to support significant numbers of juvenile salmonid prey organisms. Smith (1977) found similar areas in the Snohomish estuary recolonized quickly with preferred salmonid prey organisms after log rafting operations ceased. Filling the site with dredge spoils would result in a permanent loss of the production from the existing epibenthic community, as well as eliminate the potential for an extremely productive site if log rafting operations were to cease.

No information is available on juvenile salmonid migration/rearing at the site. However, given the size of the site and the mudflat habitat, it likely is an important rearing area. The log rafting operations probably make it a less productive rearing area than it has the potential to be. Also, this 180 acre mudflat area is one of the last remaining large intertidal mudflats in the lower portion of the Snohomish River channel. It has the potential to be a very valuable site for juvenile salmonid rearing due to its physical characteristics and the limited amount of similar habitat in the area. This area would be permanently lost under this alternative.

Secondary impacts from relocation of log rafting/storage operations would occur if dredge disposal occurs at the Snohomish River Channel site. Impacts at the present site were noticeable on the benthic community sampled from a small portion of the site. Relocation of log rafting operations to similar areas would adversely impact aquatic fauna from changes in water quality, perturbation of bottom sediments at low tide, and alteration of bottom substrate composition by addition of woody debris.

5.3.3 Combined Nearshore Site

The proposed Combined Nearshore disposal site would be created by using dredge material to fill a portion of the north end of the East Waterway. A portion of the contaminated dredge material would be used to fill approximately 14 acres to an elevation of +7 feet MLLW. The remainder of the contaminated material would have to be deposited elsewhere, such as the Snohomish Channel site. Approximately 85 acres of the Snohomish Channel site would be covered with the remaining contaminated material. The clean material would be disposed in an unconfined open water disposal site.

5.3.3.1 Dungeness Crab

Impacts on Dungeness crab from disposal of dredge material at the Combined Nearshore Site would be alteration of existing habitat in the East Waterway and the Snohomish Channel site. Limited information is available on juvenile or adult crab utilization at the Snohomish Channel site. Dredging of the downstream turning basin (located downstream from the Snohomish Channel site) has never encountered crabs. Also, on-site inspection of the Snohomish Channel site over the years has never encountered any crabs (Malek 1986). However, crab fishing does occur in the Snohomish Channel as far upstream as the Everett Public Boat Launch.

Substantial information has been collected on the use of East Waterway by Dungeness crab. Intertidal sampling in the northeast corner of the waterway showed densities of 0-age Dungeness crab ranging from 0.0 to 8.0 crab/m^2 (Weitkamp et al. 1986). Dungeness crab instars were most abundant in mid-June to July. Peak abundances in the East Waterway were 3 times that of the peak density in Port Gardner. The intertidal substrate sampled in the East Waterway was soft black, silty mud with sparse gravel patches and wood debris. There is little habitat with similar characteristics in the East Waterway. Alteration of this habitat could have adverse impacts on abundance of juvenile Dungeness crab in the East Waterway. However, the less contaminated material exposed by dredging will most likely provide better than existing habitat for juvenile crabs with the exception of bark

cover. Approximately 100 acres of this potential habitat would be lost with this alternative.

5.3.3.2 Macroinvertebrates

Densities of epibenthos and benthos known to be consumed by juvenile salmon at the Combined Nearshore site were generally low compared to other areas of the East Waterway and Port Gardner (Appendices S and T, Navy FEIS). An epibenthic sampling station in the northeast corner of the East Waterway had an average density of 148,200/m^2, as compared to 15,000 to 25,000/m^2 at adjacent sampling stations, but the dominant species present were not utilized by juvenile salmonids as prey organisms. This site produces few organisms consumed by juvenile salmon. The intertidal substrate at the north end of the East Waterway is generally large or small riprap, with little mud or soft sediment. Most epibenthic crustacea prefer soft substrate, as evidenced by the general low densities in the site area. Loss of habitat from filling the Combined Nearshore site most likely would not have significant impact on the existing density of epibenthic crustacea at the north end of the East Waterway. However, this alternative would reduce the quantity of new cleaner intertidal habitat that would be provided in the East Waterway.

Similar to epibenthic production, benthic infaunal biomass values at the Combined Nearshore site were low. Average benthic biomass values ranged from 5.2 to 47.3 g/m^2 in the East Waterway (Appendix S, Navy FEIS). Average biomass values from benthic stations near the Combined Nearshore site ranged from 9.7 to 29.9 g/m^2. These values were low compared to stations in Port Gardner and the Snohomish River which averaged 126.6 g/m^2 and 130.8 g/m^2, respectively. Diversity index values and Infaunal Trophic Index (ITI) values were similarly low, apparently illustrating the adverse impacts of contaminated sediments on marine benthos. Because of low biomass, diversity, and ITI values, impacts to benthos from dredge material disposal would be minor. However, filling the Combined Nearshore site would prevent restoration of the benthic habitat present at this site that would occur with removal of contaminated sediments. Contaminated sediment removal would facilitate recovery of the benthic community in the East Waterway.

Impacts to the aquatic fauna at the Snohomish River Channel site (the other part of the combined nearshore alternative) would be of a similar nature as described earlier (Section 4.3.3.2.), (only of a smaller magnitude. Fill at the site would decrease from 155 acres to 85 acres.

5.3.3.3 Demersal Fish

Demersal fish abundances and species composition were similar for all sampling stations located in the East Waterway (Appendix U,

Navy FEIS). A sampling station located near the Combined Nearshore site was dominated by sculpins and perch. Juveniles of economically important species, such as English sole (Parophrys vetulus) and Pacific hake (Merluccius productus) were present, but few adults were collected. Filling the site with dredge material would impact demersal fish by forcing them to move from the area, slightly decreasing available habitat. Neither of these impacts is expected to significantly reduce the abundances of demersal fish or alter the species composition.

5.3.3.4 Juvenile Salmonids

Use of the north end of East Waterway (a portion of the combined nearshore alternative) by juvenile salmonids was generally lower than other areas of the East Waterway and Port Gardner (Appendix C, Navy FEIS). Juvenile salmonid prey availability was also lower, as discussed in section 5.3.3.2. No dredging or dredge material disposal would be permitted during the "fish window," from March 15 to June 15, when juvenile salmonids are present. Habitat at the site presently consists of large and small riprap, which would be the same after completion of disposal operations. Present conditions at the site would basically be retained after disposal, which would minimize adverse impacts to juvenile salmonids.

5.3.4 Smith Island Site

As an upland site, the Smith Island disposal alternative would have no direct impacts to fisheries resources. However, as a site located near the middle of the Snohomish River delta, the potential for indirect impacts is enormous should any of the design features fail. Dike failure, dike leaking, groundwater leachate, surface water runoff following ineffective capping, or hydraulic pipeline failure could result in the release of toxicants or contaminated sediments into the environment surrounding Smith Island.

The aquatic resources susceptible to impacts from a toxicant release include juvenile salmonids, adult salmonids, and the macroinvertebrate community that serves as a food source during the juvenile salmonid outmigration. Assessing the magnitude of these impacts is not possible given the various scenarios of toxicant release that could occur. However, the importance of this area for salmonid migrations into and out of the Snohomish River Basin creates the potential for catastrophic impacts depending on the timing and magnitude of toxicant release.

The greatest potential impact for the Smith Island site is the loss of potential habitat or restored habitat. The Smith Island site is a portion of the Snohomish River Delta that has an upper intertidal elevation. This site was probably and would again be an upper intertidal wetland if the dike were removed and habitat

restoration were attempted. The site offers wetland habitat potential that can be used as mitigation for any shoreline action at another location that would require mitigation for altered wetlands. This habitat restoration potential in a productive river delta would be lost with use of the site as a contaminated material disposal site.

5.4 Secondary Impacts

The potential for secondary impacts exists as a result of port relocation activities and increased housing and development associated with the Homeport project. Port relocation activities could potentially require more dredging activities which would have impacts of a similar nature as those previously described. Increased housing and development could impact stream corridors and wetlands in the region.

It is not possible to directly evaluate the secondary project impacts stemming from direct and indirect project-related population growth because those impacts would be location specific and until actual development begins to take place, impacts cannot be assessed. Some general information can be developed for the land area consumed by project-related population growth so that land consumption can be put in the perspective of projected land consumption overall and the relative availability of developable land in areas where the greatest share of project-related population is anticipated to reside.

Using the number of single family and multi-family housing units estimated to result from direct and indirect population growth (stated in Table IV-26 of the DEISS), an estimate of the amount of residential land that would be consumed by the proposed project was developed. Based on conservative Snohomish County estimates of land consumption by housing type, single family housing units were assumed to occupy .25 acres and multi-family units .083 acres. The resultant calculations suggest that approximately 1,500 acres of residential land would be consumed by the project.

To put these figures in perspective, the amount of available developable land in those forecast and analysis zones (FAZ's) estimated to receive a population increase of at least 300 new project-related residents was calculated from PSCOG (1984) projections. Only those FAZ's receiving relatively high volumes of growth were included to provide a conservative illustration of land consumption. Without the project, 8,343 acres of vacant developable land would be consumed by County growth between 1990 and 2000, leaving 24,575 acres of vacant developable land. Including the direct and indirect residential impacts of the project, 9,837 total acres of vacant developable land would be taken up by the project, leaving 23,081 acres for future use. A substantial amount of vacant developable land would remain even

in the high growth corridor for future uses without impacting environmentally sensitive areas.

Local jurisdictions, such as Snohomish County, have defined environmentally sensitive areas such as steep slopes and stream corridors and have taken measures to protect them from impacts of future growth. Additionally, any significant local development projects would come under environmental review through the State Environmental Policy Act (SEPA), the locally adopted environmental policy regulations (which must be at least as stringent as SEPA), or the National Environmental Policy Act so that adequate environmental protection measures can be taken.

6. AIR QUALITY IMPACTS

Pursuant to the USEPA correspondence of July 29, 1985, and a subsequent project meeting on February 10, 1986, a supplemental analysis of the proposed homeporting project at Everett, Washington was performed. The following three tasks were initiated to supplement the air quality analysis contained in the Navy FEIS:

- o updated construction scenarios and emissions;
- o revised air quality modeling of stationary ship and onshore sources; and
- o revised air quality modeling of onshore mobile sources.

6.1. Construction - Scenarios and Emissions

Construction of the proposed homeport has been divided into 10 different activities. Beginning in January 1987 and lasting through 1990, these construction activities vary in duration and would include both marine construction and onshore operations. Because of the proposed arrival date of battle group carrier on January 1, 1989, the majority of work would be completed by this date. Building construction is the only activity scheduled in 1990. Construction emissions were calculated for each of the ten activities.

6.1.1. Construction Scenarios

The first activity to commence in January 1987 would be the dredging and spoils disposal of the carrier pier/breakwater area. A 15 cubic yard (cy) clam shell dredge on a barge would be the major piece of equipment. Under the preferred dredge disposal option (confined aquatic disposal at the RAD CAD site) a 1,000 HP tug with 3 to 4 dump scows would be dedicated to this activity. Dredging and disposal would be a 24 hour per day operation.

Demolition of 30 existing Western Gear buildings and 6 port structures at the Norton Terminal site would be the first land-based activity. Onshore activity would entail blasting and wrecking ball demolition techniques, while the pier/port structures would require a barge-based crane with clamshell or grappling tongs. The demolition debris would be transported from the site using haul trucks. As with normal sitework, water trucks would be used to reduce dust emissions.

Following completion of the carrier pier area dredging, construction of the breakwater and carrier pier would begin. This marine construction activity would consist of rock placement for the breakwater (using a barge-based crane with clamshell) and pile driving for the carrier pier. The pre-cast piles (24-inch octagonal with 130 to 170 feet in length) necessitates the use of a large-based crane. Likewise, the vast amount of rock would

also require a similar size crane with a clamshell. Rock transport would be conducted by 2,000 horsepower tugs towing 2,500 cubic yard barges. Emissions from this activity do not include any overland rock haul or placement.

The largest construction activity of the proposed homeport is the dredging of the inner and outer East Waterway. The volume of materials to be dredged may require the use of two large clamshell dredges operating simultaneously.

The disposal scenario would be the same as the carrier pier dredge disposal. Contaminated material is presumed to be released by bottom dump scow. Approximately 370,000 cubic yards of material landward of MHW on the east side of central mole would be excavated by clamshell dredge.

The entire shoreline of the central and south mole would be strengthened by placement of rock. This 6-month activity would require use of a barge-based crane. It is expected that there will be some land based rock placement by crawler crane with clamshell. Rock would be barged in on a 2,500 cubic yard rock barge. The completion of the carrier pier and construction of the south and central marginal wharf would be the last marine construction activity to commence. Piles (approximately 2,700) would be driven, pile caps made, and precast panels would be set by a work barge with large crane. Transport of piles and panels would be done by 1000 cubic yard barges, while concrete would be trucked to the site. Additional equipment used would include concrete pump rigs and welding units.

Onshore sitework has been divided into two activities, the Norton Terminal area and construction at the south and central mole area. 342,000 cubic yards of granular fill and/or compacted selected fill will be imported to raise grade elevation at both areas. Existing graving docks on the west side, facing the Snohomish river channel, would be filled. Standard earthwork equipment would be used. In addition to the aforementioned rock placement, the south and central mole would be strengthened by slope work conducted by dozers and grading equipment. Trenches would be dug for proposed outfalls and sea water intakes. Lastly, asphalt concrete pavement would be laid on all wharf and pier areas.

The construction of all utility systems is a separate activity that is necessary before carrier arrival. The erection of steam plant boilers, and fuel tankage would employ various size cranes. Distribution lines (serving all berths) would be placed in a large main utility corridor, running the entire length of the south and central mole. Fuel, steam, and water pipelines would be welded.

Building construction at the Norton Terminal would be the last activity to commence. Erection of transit storage and a supply depot would require pile driving and crane work. The construction of other buildings (barracks, galley, etc.) would be completed in increments, lasting through 1990. Half of the Norton Avenue Terminal site would be dedicated to parking area for the battle group.

6.1.2. <u>Air Emissions</u>

Construction emissions of nonmethane hydrocarbons (ROC), sulfur dioxide (SO_2), carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM) have been calculated for each activity, itemized by combustion sources. A summary of total construction emissions per activity is presented in Table 6-1. Due to the different durations of activities, separate estimates of daily emission rates have been developed and listed for each activity in Table 6-2. Itemization of emissions per source for each activity is compiled in Table 6-3.

Table 6-1 shows that dredging of the inner and outer harbor is the activity with greatest amount of emissions for all five pollutants, while the carrier pier/breakwater dredging is the smallest. The main sources of dredging emissions are the clamshell dredge and debris haul trucks. Breakwater construction is the second largest activity, in terms of emissions. Rock barge tugs account for over half of the carrier pier pile driving/breakwater construction emissions.

On a daily basis, slope protection and stabilization is the greatest emitter of all five pollutants. Again, rock barge tugs make up more than half the emissions. Central and south wharf sitework is the lowest emitter of all five pollutants. Daily emissions were estimated using 22 working days per month. Due to the construction schedule expediency daily emissions for some activities could decrease if more working days per month would occur.

Because of the tremendous amount of bulk material (dredge material, debris, rock, piles, etc.), many of the estimated emissions are based on material amount. Contractor supplied estimates of equipment usage per material amount is prevalent throughout the marine construction activity, while onshore site and building work is estimated on a time basis, given a certain equipment spread. Marine contractors construction methods can vary. For instance, debris removal could be hauled away by barge for salvage and some pier and wharf construction could be conducted by land base methods. Thus, these estimates reflect best preliminary engineering judgement.

Table 6-1. Total Construction Air Emissions (per activity). Proposed U.S. Navy Homeport - Everett, Washington.

Activity	Pollutant/Emissions(tons) ROC	NOx	SO2	CO	PM
Carrier Pier/Breakwater Dredging	0.61	8.56	0.84	2.31	0.73
Carrier Pier Pile Driving/Breakwater Construction	3.69	73.73	5.65	15.05	5.05
Structure and Pier Demolition	4.14	41.55	4.63	12.65	3.43
Outer/Inner Harbor Dredging	7.85	90.16	10.16	27.11	8.14
Slope Protection and Stabilization	1.89	31.92	2.52	6.42	2.23
Pier/Wharf Completion	3.84	55.64	4.70	13.99	4.39
Norton Terminal Fill and Excavation	4.04	35.55	4.56	14.02	3.43
Central and South Wharf Sitework	0.89	11.40	1.22	3.50	0.89
Norton Terminal Building Construction	5.73	63.78	5.18	22.25	5.03
Total Construction Emissions:	32.67	412.29	39.47	117.30	33.33

Table 6-2. Average Daily Construction Emissions (per activity). Proposed U.S. Navy Homeport - Everett, Washington.

Activity	Pollutant/Emissions(lbs./day) ROC	NOx	SO_2	CO	PM
Carrier Pier/Breakwater Dredging	9.24	129.71	12.72	34.95	11.11
Carrier Pier Pile Driving/Breakwater Construction	21.63	432.42	33.13	88.29	29.63
Structure and Pier Demolition	41.78	419.71	46.77	127.77	34.69
Outer/Inner Harbor Dredging	39.64	455.34	51.31	136.92	41.11
Slope Protection and Stabilization	28.68	483.67	38.22	97.23	33.78
Pier/Wharf Completion	20.56	297.53	25.13	74.78	23.46
Norton Terminal Fill and Excavation	30.60	269.30	34.57	106.23	25.95
Central and South Wharf Sitework	6.71	26.36	9.25	26.52	6.78
Norton Terminal Building Construction	14.46	161.07	13.09	56.20	12.71

Table 6-3. Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

1. Carrier Pier/Breakwater Dredging

Basis: Hours/day = 24

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Dredging	Clamshell Dredge/Prime Mover		0.110	4.125	0.481	1.100	0.413
	Barge Anchor Winch		0.010	0.119	0.008	0.023	0.009
	Auxiliary Generator (250 KW)		0.108	1.345	0.089	0.291	0.096
Disposal	Dump Scow Tug - idle		0.204	0.292	0.046	0.393	0.040
	- cruise/maneuver		0.128	2.290	0.159	0.368	0.140
	Dump Scow		0.004	0.050	0.003	0.011	0.004
Debris Removal	Loader						
	Haul Trucks - haul		0.045	0.336	0.052	0.114	0.032
	- idle		0.002	0.003	0.000	0.004	0.000
		Total:	0.610	8.561	0.340	2.307	0.733
		Average lb/day:	9.24	129.71	12.72	34.95	11.11

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

2. Carrier Pier Pile Driving/Breakwater Construction

Basis:

Total # of Piles = 962
Pile Driving Rate (Piles/day) = 8
Hours/day = 10

			Emissions (tons)				
Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
Pile Driving	Barge Crane	1	0.115	4.329	0.505	1.154	0.433
	Auxiliary Generator (250 KW)	1	0.248	3.106	0.207	0.672	0.222
	Hydro Jet Pump	1	0.039	0.493	0.033	0.107	0.035
	Pile Driver Hammer (air)	1	0.178	2.225	0.148	0.482	0.159
	Barge Anchor Winch	1	0.022	0.275	0.018	0.060	0.020
	Support Boat	1	0.072	0.297	0.020	0.102	0.018
Pile Transport	Barge Tug	1	0.086	1.543	0.107	0.246	0.095
Rock placement	Barge Crane w/15 yd^3 clamshell	1	0.195	7.327	0.855	1.954	0.733
	Auxiliary Generator (250 KW)	1	0.168	2.103	0.140	0.455	0.150
	Front End Loader	1	0.050	0.450	0.044	0.139	0.041
	Barge Anchor Winch	1	0.015	0.186	0.012	0.040	0.013
	Support Boat (sounding)	1	0.049	7.584	0.509	2.607	0.448
Rock Transport	Rock Barge Tug	1	2.449	43.308	3.050	7.035	2.685
		Totals:	3.687	73.727	5.648	15.054	5.052
		Average lb/day:	21.63	432.42	33.13	88.29	29.63

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

3. Structure and Pier Demolition

Basis: Duration (months) = 6
Demolition Debris (cubic)
Hours/Day = 6
Days/Month = 22

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Structure Demolition	100 Ton Crane	1	0.102	1.114	0.094	0.465	0.091
	50 Ton Crane	1	0.070	0.768	0.065	0.321	0.063
	D-8 Dozer	2	0.077	1.706	0.186	0.477	0.163
	D-6 Dozer	1	0.018	0.398	0.043	0.111	0.038
	Backhoe	2	0.183	1.998	0.169	0.835	0.163
	Compressor	2	0.085	1.221	0.070	0.262	0.087
	Track Front End Loader	3	0.193	1.752	0.171	0.539	0.161
	Water Truck	1	0.037	0.810	0.088	0.227	0.050
Debris Transport	Trucks (20 cu.yd.)		2.366	17.765	2.738	6.030	1.672
	- idle		0.083	0.145	0.015	0.204	0.009
Pier Demolition	Barge Crane		0.300	3.274	0.277	1.368	0.268
	Auxiliary Generator		0.129	1.859	0.106	0.398	0.133
	Barge Anchor Winch		0.013	0.165	0.011	0.036	0.012
	Salvage Barge Tug (cruise)		0.479	8.575	0.597	1.377	0.526
		Totals:	4.136	41.551	4.630	12.649	3.435
		Average lb/day:	41.78	419.71	46.77	127.77	34.69

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

4. Outer/Inner Harbor Dredging

Basis: Hours/day = 24

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Dredging	Clamshell Dredge/Prime Mover	1	1.004	37.714	4.400	10.057	3.771
	Barge Anchor Winch		0.087	1.090	0.073	0.236	0.076
	Auxiliary Generator (250 KW)		0.984	12.298	0.818	2.662	0.878
Disposal	Dump Scow Tug - idle		1.763	2.522	0.397	3.393	0.349
	- cruise/maneuver		0.568	10.160	0.707	1.631	0.623
	Dump Scow		0.037	0.459	0.031	0.099	0.033
Debris Removal	50 Ton Crane	1	0.147	1.601	0.135	0.669	0.131
	Loader	2	0.268	2.433	0.236	0.749	0.224
	Haul Trucks - haul		2.890	21.702	3.344	7.366	2.042
	- idle		0.101	0.178	0.018	0.249	0.011
		Total:	7.848	90.157	10.160	27.110	8.140
		Average lb/day:	39.64	455.34	51.31	136.92	41.11

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

5. Slope Protection and Stabilization

Basis: Rock Quantities Seawa Mole

Hours/Day = 10

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Rock Placement	Barge Crane w/15 yd clamshell	1	0.118	4.420	0.516	1.179	0.442
	Auxiliary Generator (250KW)	1	0.101	1.268	0.084	0.274	0.091
	Front End Loader	1	0.030	0.272	0.027	0.084	0.025
	Barge Anchor Wincn	1	0.009	0.112	0.007	0.024	0.008
	Crawler Crane	1	0.165	1.801	0.152	0.752	0.148
	Support Boat (sounding)	1	0.080	0.326	0.022	0.112	0.019
Rock Transport	Rock Barge Tug	1	1.237	22.134	1.541	3.554	1.357
Grading/shaping	D-6 Dozer	2	0.153	1.590	0.173	0.438	0.141
		Totals:	1.893	31.923	2.523	6.417	2.230
		Average lb/day:	28.68	483.67	38.22	97.23	33.78

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

6. Pier/Wharf Completion

Basis:
- Total # of Piles = 2650
- Pile Driving Rate (Piles/day) = 6
- Hours/day = 10

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Pile Driving	Barge Crane	1	0.317	11.925	1.391	3.180	1.193
	Auxiliary Generator (250 KW)	1	0.684	8.555	0.569	1.852	0.611
	Hydro Jet Pump	1	0.109	1.359	0.090	0.294	0.097
	Pile Driver Hammer (air)	1	0.490	6.129	0.408	1.326	0.438
	Barge Ancnor winch	1	0.061	0.759	0.050	0.164	0.054
	Support Boat	1	0.200	0.913	0.055	0.281	0.048
Pile Transport	Barge Tug	1	0.238	4.261	0.297	0.684	0.261
Panel Setting	Barge Crane	1	0.054	2.023	0.236	0.539	0.202
	Auxiliary Generator (250 KW)	1	0.124	1.555	0.103	0.336	0.111
	Barge Anchor Winch	1	0.011	0.138	0.009	0.030	0.010
Panel Transport	arge Tug	1	0.260	4.646	0.323	0.746	0.285
Panel Welding	welding Machine		0.186	2.320	0.154	0.502	0.166
Cementing Panels/Caps	Crawler Crane		0.440	4.802	0.406	2.006	0.393
	Concrete Pump Rig		0.067	0.835	0.056	0.181	0.060
	Cement Mixing Trucks (7.5 yds/truck)		0.243	1.450	0.255	0.720	0.156
	-idle		0.023	0.040	0.004	0.056	0.002
Sheet Pile Driving	Crawler Crane		0.049	0.538	0.046	0.225	0.044
	Sheet Pile Hammer		0.235	2.936	0.195	0.635	0.210
	Compressor		0.004	0.045	0.003	0.010	0.003
	15 Ton Hydraulic Crane (unload)		0.042	0.460	0.039	0.192	0.038
Pile Transport	Flatbed Truck (30 sheets/truck)		0.003	0.047	0.008	0.023	0.005
	-idle		0.000	0.001	0.000	0.001	0.000
		Totals:	3.345	55.639	4.699	13.984	4.387
		Average lb/day:	20.56	297.53	25.13	74.78	23.46

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

7. Norton Terminal Fill and Excavation

Basis:

Hours/day	=	8
Months	=	12
Days/Month	=	22

Mode	Equipment/source	#	Emissions (tons) ROC	NOx	SO2	CO	PM
Site Work	Scraper	1	0.352	4.772	0.576	1.567	0.505
	D-8 Dozer	2	0.523	5.450	0.594	1.500	0.483
	D-6 Dozer	1	0.170	1.771	0.193	0.488	0.157
	Motor Grader	1	0.057	1.121	0.137	0.242	0.100
	Compacter	1	0.364	3.969	0.336	1.658	0.325
	Backhoe	2	0.190	2.074	0.176	0.867	0.170
	Water Truck	1	0.109	1.484	0.179	0.487	0.157
	Dump Truck	2	0.146	1.978	0.239	0.650	0.209
	Roller	1	0.095	1.275	0.098	0.589	0.076
Fill Import	Haul Trucks (9 yds)		1.914	11.444	2.015	5.681	1.230
			0.119	0.209	0.021	0.293	0.013
		Total:	4.040	35.547	4.564	14.022	3.426
		Average lb/day:	30.60	269.30	34.57	106.23	25.95

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

8. Utility Plant and Corridor Construction

Basis:

Hours/day	=	8
Months	=	12
Days/Month	=	22

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Erection	15 Ton Hydraulic Crane	4	0.489	5.327	0.451	2.226	0.436
	50 Ton Crane	1	0.310	3.380	0.286	1.412	0.277
	Welding Machine	5	0.326	4.070	0.271	0.881	0.291
	Excavator	1	0.252	2.109	0.193	0.513	0.149
	Backhoe	2	0.235	2.561	0.217	1.070	0.210
	Large Forklift	1	0.120	1.306	0.111	0.546	0.107
	Small Forklift	1	0.063	0.691	0.059	0.289	0.057
	Compressor	2	0.117	1.465	0.097	0.317	0.105
	Pile Driver	1	0.098	1.221	0.081	0.264	0.087
Cement Transport	Cement Mixing Trucks (7.5 yds/truck)		0.336	2.008	0.354	0.997	0.216
	-idle		0.031	0.055	0.006	0.077	0.003
Material Transport	Flatbed Truck		0.097	0.727	0.112	0.247	0.068
	-idle		0.010	0.017	0.002	0.024	0.001
		Total:	2.483	24.939	2.238	8.862	2.007
		Average lb/day:	18.81	198.93	16.96	67.14	15.20

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

9. Central and South Wharf Sitework

Basis:

Hours/day = 8
Months = 12
Days/Month = 22

Mode	Equipment/source	#	ROC	NOx	SO2	CO	PM
			Emissions (tons)				
Grading/Fill	Motor Grader	1	0.068	1.345	0.165	0.290	0.120
	Large Loader	1	0.214	1.947	0.190	0.599	0.179
	D-7 Dozer	1	0.174	1.817	0.198	0.500	0.161
	Backhoe	1	0.117	1.280	0.108	0.535	0.105
	Paver	1	0.027	0.299	0.025	0.125	0.024
	Dump Truck	4	0.196	4.322	0.470	1.209	0.266
Asphalt Hauling	Haul Trucks (9 yds)		0.056	0.335	0.059	0.166	0.036
	-idle		0.031	0.055	0.006	0.077	0.003
		Total:	0.885	11.400	1.221	3.501	0.894
		Average lb/day:	6.71	86.36	9.25	26.52	6.78

Table 6-3. (Contd.) Proposed Homeport Construction Emissions. U. S. Navy Proposed Homeport Construction Emissions (per activity/source).

10. Norton Terminal Building Construction

Basis:

Hours/day	=	8
Months	=	36
Days/Month	=	22

Mode	Equipment/source	#	Emissions (tons) ROC	NOx	SO2	CO	PM
Erection & Paving	Pile Driver	1	0.195	2.442	0.162	0.529	0.174
	Large Forklift	2	0.719	7.836	0.663	3.274	0.642
	Small Forklift	2	0.381	4.149	0.351	1.733	0.340
	15 Ton Hydraulic Crane	4	1.466	15.980	1.353	6.677	1.309
	50 Ton Crane	1	0.930	10.141	0.858	4.237	0.831
	100 Ton Crane	1	0.102	1.114	0.094	0.465	0.091
	Welding Machine	5	0.977	12.211	0.812	2.643	0.872
	Compressor	3	0.528	6.594	0.439	1.427	0.471
	Paver	1	0.082	0.896	0.076	0.374	0.073
Material Transport	Flatbed Truck		0.290	2.180	0.336	0.740	0.205
	-idle		0.003	0.006	0.001	0.009	0.000
Asphalt Hauling	Haul Trucks (9 yds)		0.034	0.201	0.035	0.100	0.022
	-idle		0.019	0.033	0.003	0.046	0.002
		Total:	5.726	63.785	5.184	22.254	5.033
		Average lb/day:	14.46	161.07	13.09	56.20	12.71

6.2. Ship and Onshore Construction Emission Source Modeling

Additional atmospheric dispersion modeling was performed in response to USEPA comments regarding the FEIS air quality impact analysis. The revised modeling incorporates a more realistic account of hoteling emissions during ship berthing and secondary impacts from nearby automobile traffic. The procedures and analyses provided in this report are to be considered supplemental to the FEIS and are consistent with USEPA recommendations set forth in their July 19, 1985, letter and subsequent February 10, 1986, project meeting.

6.2.1. Modeling Protocol

Pursuant to USEPA comments on the Navy FEIS air quality impact analysis, the following modeling protocol elements were developed for the evaluation of homeporting impacts.

- Medical-Dental Clinic wind data and Sea Tac cloud data measured during 1984 were combined with Holtzworth mixing height estimates for Sea Tac and climatological monthly mean temperatures for Sea Tac using procedures described in the EPA-published CRSTER manual.

- During berthing, each ship will hotel for about 1/2 hour and it is estimated that 5 ships can be berthed in 3 hours. Therefore, hoteling emissions were calculated as follows:

    - All thirteen ships, including the tender destroyer and the four naval reserve ships, were modeled for 24-hour concentrations. For the shorter averaging time of 15-minutes, 1-hour, and 3-hour, the number of ships modeled were 1, 2, and 5 respectively.

    - Since hoteling occurs for 30 minutes for each ship, emission rates for modeled ships are divided by 2, 6, and 48 for modeling of 1-hour, 3-hour, and 24-hour pollutant impacts.

    - For hoteling, the small onshore boiler operates continuously, and, for 24-hour averaging times, the larger boiler operates for 16 hours (hours remaining after the 8 hours required for berthing).

    - For 24-hr and annual averaging times for both hoteling and onshore operations, crane emissions were weighted for an 8-hour workday.

- A cartesian receptor grid with 1-kilometer (km) grid spacing was generated for the project area. In areas of maximum impacts (as determined by modeling), an additional 1/2-km receptor grid was included. Receptors within Navy property boundaries were excluded from analysis.

Ship and onshore pollutant emissions are summarized in Table 6-4. These emissions are presented for averaging times (e.g., 5-minute, 1-hour, 24-hour, etc.) pertinent to ambient air quality standards for SO_2, TSP, and NO_2. All stack characteristics (excluding emission rates) are identified to those parameters in the Navy FEIS.

Two USEPA-approved models were utilized in the refined modeling effort. MPTER is a multiple-source dispersion model designed for situations with relative flat terrain. For over-water or near-sea level receptor at elevations less than the lowest modeling stack height, MPTER was run. For those receptors above the lowest modeled stack height, COMPLEX-I was utilized. This model was developed for complex (mountainous) terrain and is characterized by dispersion parameters representative for air flow over rough surfaces. As previously mentioned, the MPTER and COMPLEX-I models were executed with wind speed and wind direction from the PSAPCA Medical-Dental Clinic site and cloud data from the Seattle-Tacoma Airport for a one-year period of record.

Ship maneuvering in the immediate vicinity of the dock will be the result of ships entering or leaving the port one after another. Ship propulsion systems will be operating at about 26 percent of full power. It is extremely unlikely that more than one or two ships will be in the maneuvering mode in the dock area at one time. In addition, maneuvering ships are moving emission sources which will be removed from the area in a matter of minutes.

In reviewing modeling scenarios, it is quite apparent that a moving ship operating at 26 percent of full power with a short residence time adjacent to the dock will have a lower impact on ambient air quality than a stationary ship operating at 20 percent of full power during hoteling. Furthermore, once the maneuvering ship has left the dock vicinity, it no longer contributes to the ambient air impact of the homeporting facility.

To be extremely conservative in evaluating port impacts on ambient air quality, one could assume that two ships were in the maneuvering mode adjacent to the dock while the remainder of the battle group was in the hoteling phase. This situation is highly unlikely since the ships are connected to onshore power within 30 minutes of berthing. This onshore hookup is conducted on a ship-by-ship basis and not all ships at once. Assuming that the two

Table 6-4. Ship and Onshore Emissions for Complex I and MPTER Modelng (g/s).

Scenario/Source[a]	SO_2 5-min	SO_2 1-hr	SO_2 3-hr	SO_2 24-hr	SO_2 Annual	PM 24-hr	PM Annual	NO_x Annual
Hoteling								
Small Boiler	0.00	0.00	0.00	0.00	-[b]	0.00	-	-
Large Boiler	-	-	-	0.008	-	0.051	-	-
Crane	0.11	0.11	0.11	0.036	-	0.047	-	-
CG	-[c]	0.48	0.16	0.020	-	0.003	-	-
CG	-	-	-	0.020	-	0.003	-	-
DD	-	-	0.12	0.015	-	0.002	-	-
DD	-	-	-	0.015	-	0.002	-	-
DDG	-	-	0.12	0.015	-	0.002	-	-
DDG	-	-	-	0.015	-	0.002	-	-
FFG	-	-	0.12	0.015	-	0.002	-	-
FFG	-	-	-	0.015	-	0.002	-	-
FFG	-	-	-	0.015	-	0.002	-	-
FFG	-	-	-	0.015	-	0.002	-	-
MCM	-	-	-	0.006	-	0.002	-	-
MCM	-	-	-	0.006	-	0.002	-	-
AD	1.10	0.55	0.18	0.023	-	0.001	-	-
Onshore Operations								
Small Boiler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Large Boiler	0.01	0.01	0.01	0.01	0.01	0.08	0.08	2.13
Crane	0.11	0.11	0.11	0.036	0.036	0.047	0.047	0.51

a Source abbreviations and stack characteristics are identical to the FEIS. Emissions were calculated from FEIS information as described in the text.

b Annual impacts are inappropriate for modeling of hoteling emissions due to limited nature of ship berthing (a few days each year).

c Since only 1 or 2 ships can be berthing at any instantaneous moment, shorter averaging times have fewer than the total 13 ships for sources.

ships are in the maneuvering mode at 26 percent of full power adjacent to their berths, supplemental modeling of this hoteling-/maneuvering scenario was conducted. Results of this modeling are provided in Table 6-5. The highest second-highest 24-hour and SO_2 and TSP concentrations were predicted to be less than USEPA-designated significant impact level of 5 ug/m^3. Since these SO_2 and TSP projected impacts are less than USEPA-designated significant impact levels, the project SO_2 and TSP emissions are not expected to significantly affect existing ambient SO_2 and TSP levels for these averaging periods.

Table 6-5. Additional Complex I modeling results due to maneuvering/hoteling emissions

Pollutant/ Averaging Time	Concentrations (ug/m^3)	Ambient Air Quality Standards (ug/m^3) National Primary	National Secondary	Wash. State	PSAPCA
SO_2 5-min	148	-	-	-	2620
1-hr	89	-	-	1048	1048
3-hr High	67	-	-	-	-
3-hr 2nd High	42	-	1300	-	-
24-hr High	3.1	-	-	-	262
24-hr 2nd High	3.0	365	-	262	-
Annual	N/A	80	-	50	50
TSP 24-hr	3.8	260	150	150	150
24-hr 2nd High	3.6	-	-	-	-
Annual	N/A	75	60	60	60
NO_2 Annual	N/A	100	100	100	100

The highest second-highest 3-hour SO^2 concentration was predicted to be greater than the USEPA-designated significant impact level of 25 ug/m^3. Since, however, this concentration is only about 3 percent of the 3-hour SO_2 standard, the project is not expected to cause or contribute to violations of the federal standard.

6.2.2. Modeling Results

Impact on ambient air quality from stationary ships and onshore sources are summarized in Table 6-4. Concentration estimates are presented for hoteling and onshore operations. The highest second-highest 3-hour, the highest second-highest 24-hours, and highest annual SO_2 concentrations were predicted to be less than USEPA-designated significance levels of 25 ug/m^3, 5 ug/m^3, and 1 ug/m^3, respectively. The highest second-highest 24-hour and highest annual TSP concentrations were all shown to be less than

significance levels of 5 ug/m^3 and 1 ug/m^3, respectively. Note that the short-term SO_2 impacts were evaluated with consideration of calm wind in accordance with USEPA procedures documented in Section 9.3.4.2 of the draft <u>Guideline on Air Quality Models</u> (revised). Since the SO_2 and TSP project impacts are less than USEPA-designated significance levels, project SO_2 and TSP emissions are not expected to significantly affect existing SO_2 or TSP air quality levels.

The maximum annual NO_2 concentration was predicted to be greater than the USEPA-designated significance level of 1 ug/m^3. An isopleth map of annual NO_2 concentrations is presented in Figure 6-1. Since the maximum concentration is only about 3 percent of the annual NO_2 standard, the project is not expected to cause or contribute to violations of the federal standards. Further modeling of NO_2 emissions from other nearby sources is considered unnecessary.

On the basis of USEPA Document No. EPA-450/2-78-027 <u>Guideline on Air Quality Models</u> dated April 1978, it's proposed revision dated October 1980, and USEPA-sponsored air quality modeling workshops, it has become industry-wide practice to conduct dispersion modeling in a phased manner. Phase I consists of "coarse grid" modeling which assesses source impacts at receptors extending from the source in a rectangular format. Typical receptor spacing is 0.5 - 1.0 km for this Phase I effort. USEPA suggest 1-kilometer spacing in their proposed revision to EPA-450/2-78-027. If areas of high ground-level concentrations (or "hot spots") are identified in the coarse grid modeling, Phase II is then initiated. Phase II modeling consists of supplementing the coarse grid with additional receptors in areas of hot spots to form a "fin grid". Note that fine grid modeling is typically required only when hot spots appear in the coarse grid modeling which approach or exceed National Ambient Air Quality Standards (NAAQS) or Prevention of Significant Deterioration (PSD) increments.

The U.S. Navy Homeporting air quality was performed utilizing a receptor grid with 0.5-kilometer receptor spacing. Results of this modeling yielded ambient air impacts well below NAAQS for all pollutants. In fact, air pollutant impact except for NO_2 was less than the USEPA-designated significant impact levels. Annual NO_2 impacts were only 3 percent of the NAAQS. Due to the extremely low predicted concentrations represented in the coarse grid modeling, no hot spots were identified and no further refined grid modeling was necessitated.

Use of a rectangular grid is rather straightforward in areas of flat terrain. In elevation (hilly) terrain where plume impacts are influenced by topography, discrete receptor location may be appropriate. Elevated terrain does exist in the vicinity of the homeporting project. The air quality modeling for the project

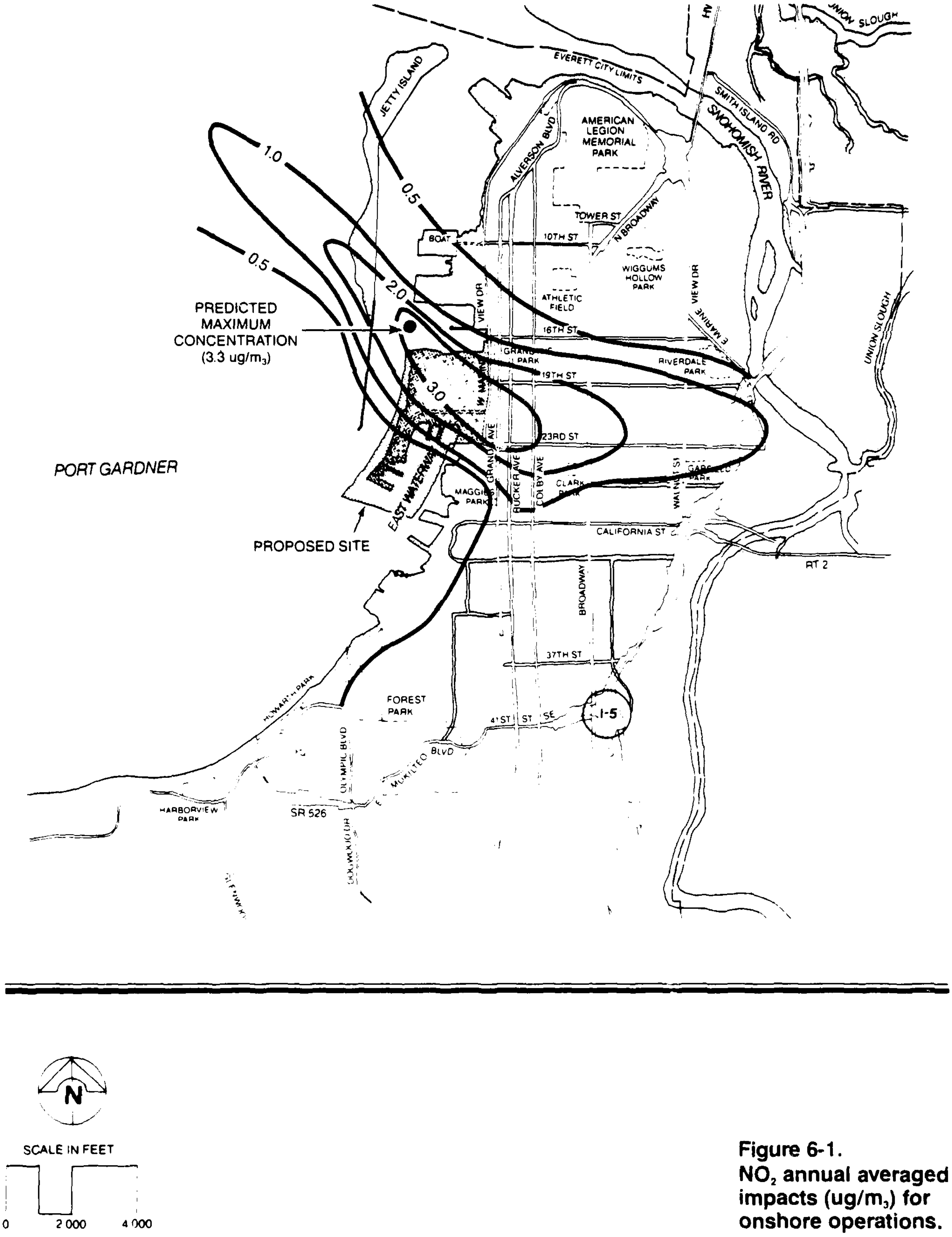


Figure 6-1.
NO_2 annual averaged impacts (ug/m_3) for onshore operations.

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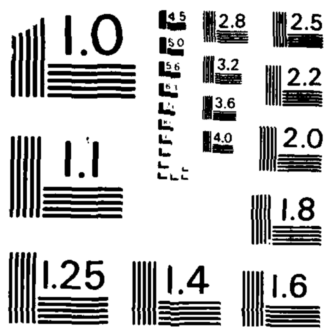

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does include receptors in these elevated terrain areas. For short-term (e.g., 1-hour, 3-hour, etc.) impacts, the maximum ground-level concentrations due to project emissions were predicted to occur in these areas. Fine grid modeling of the elevated terrain areas was not conducted, however, since the coarse grid modeling results demonstrated that expected impacts would be less than USEPA-designated significant impact levels.

In response to USEPA-Region X concern that maximum concentrations have not been identified, additional modeling in the areas of elevated terrain in the project vicinity has been performed for discrete receptor locations with 0.2-kilometer spacing. Results of this modeling are presented in the attached Table 6-6. The highest second-highest 24-hour and highest annual SO_2 and TSP concentrations were predicted to be less than USEPA-designated significant impact levels of 5 ug/m^3 and 1 ug/m^3, respectively. Since these SO_2 and TSP projected impacts are less than USEPA-designated significant impact levels, the project SO_2 and TSP emissions are not expected to significantly affect existing ambient SO_2 and TSP levels for these averaging periods.

Table 6-6. Additional Complex I modeling results due to hoteling and operation emissions

Pollutant/ Averaging Time	Concentrations (ug/m^3)	Ambient Air Quality Standards (ug/m^3) National Primary	National Secondary	Wash. State	PSAPCA
SO_2 5-min	114	-	-	-	2620
1-hr	68	-	-	1048	1048
3-hr High	42	-	-	-	-
3-hr 2nd High	31	-	1300	-	-
24-hr High	3.1	-	-	-	262
24-hr 2nd High	3.0	365	-	262	-
Annual	0.3	80	-	50	50
TSP 24-hr	3.8	260	150	150	150
24-hr 2nd High	3.6	-	-	-	-
Annual	0.4	75	60	60	60
NO_2 Annual	4.9	100	100	100	100

The highest second-highest 3-hour SO_2 concentration and maximum annual NO_2 concentration were predicted to be greater than the USEPA-designated significant impact levels of 25 ug/^{3} and 1 ug/m^3, respectively. Since, however, these concentrations are only about 2 percent of the 3-hour SO_2 standard and about 5

percent of the annual NO_2 standard, the project is not expected to cause or contribute to violations of either federal standard.

All air quality modeling was performed for both daylight and nighttime hours (i.e., 24-hours per day). Since the majority of emissions will occur during the daylight hours while the maximum model-predicted impacts were estimated to occur during nighttime hours, the modeling results for all pollutants can be considered conservative approximations of expected ambient air concentrations during actual operations.

6.3. Effects of Traffic

Analyses were performed to estimate the impact of project-related traffic on ambient air quality. The analyses consisted of estimating mobile source emissions during the first year of project operations (1990) and then calculating potential air quality impacts resulting from these emissions.

6.3.1. Mobile Source Emissions

Traffic related emissions generally consist of carbon monoxide (CO), oxides of nitrogen (NO_x), and hydrocarbons (HC) and result from the use of gasoline or diesel power internal combustion engines in motor vehicles. Analyses were performed for CO emissions, as this is the pollutant of primary interest when performing mobile source modeling. Also, no modeling techniques are readily available for calculating annual mobile source NO_x impacts and NO_x to NO_2 conversion or secondary O_3 impacts due to mobile source HC emissions.

The emissions estimates were performed for 1990, the first expected year of normal project operations. Emission factors contained in MOBILE3 (EPA, 1981) were used to calculate CO and NO_x emissions (in grams/vehicle/mile). MOBILE3 is an EPA-developed computer program which calculates an average vehicle emission rate based on user-supplied input data. These input data include:

- vehicle percentages (up to 8 different vehicle types may be specified)
- ambient temperature
- vehicle speed
- calendar year (restricted to 1970 through 2020, inclusive)
- Inspection and Maintenance (I/M) program requirements
- vehicle loading factors

- o vehicle operating mode (cold start, hot start, and hot stabilized percentages).

MOBILE3 input data were chosen in order to calculate, as much as possible, realistic conservative conditions. Maximum concentration generally occur during winter months because vehicle CO emissions increase with decreasing temperature. An ambient temperature of 36° F was input to MOBILE3. This temperature is the average daily minimum temperature for the months of November through February in Seattle based on 30 years of data (Kircher, 1984).

Emissions were calculated by MOBILE3 using non-California low altitude emissions factors. All possible vehicle speeds were considered for later use in calculating CO impacts. Vehicle characteristics suggested by the Puget Sound Air Pollution Control Agency (PSAPCA) were used as input to MOBILE3 (Kircher, 1984). Vehicle miles traveled percentages and vehicle age distributions for the State of Washington, shown in Table 6-7, were used for input to MOBILE3. Vehicle operations modes were based on data specific to the Puget Sound area, which includes all the project areas studied. These assumed vehicle operation modes were as follows: 18.4 percent of vehicles not equipped with catalytic converters were operating in a cold start mode while 18.1 percent and 29.6 percent of vehicles equipped with catalytic converters were being operated under cold-start and hot-stabilized conditions, respectively.

No vehicle loading factors (such as trailer towing or air conditioning) were used for light-duty gasoline vehicles. Also, no Inspection/Maintenance program was used for any project site, since there are no requirements for an I/M program in the Everett area.

Calculated MOBILE3 CO emission factors are given in Table 6-8. In general, CO emissions (in grams/vehicle-mile) increase with decreasing vehicle speed. These CO emission factors were used for all project areas modeled.

6.3.2. <u>Air Quality Impact Analysis</u>

Using the emissions data discussed above, air quality modeling was conducted to estimate ambient CO concentrations resulting from the various project alternatives. Concentrations of CO were calculated with the CALINE3 dispersion model developed by the California Department of Transportation (Benson, 1979). CALINE3 is specifically formulated to calculate concentrations due to

Table 6-7. Estimated vehicle registration for Washington State (%) by model year and vehicle type.

	VEHICLE TYPE							
Model Year	LDGV	LDGT1	LDGT2	HDGV	LDDV	LDDT	HDDV	MC
1990	4.5[a]	6.1	3.7	3.7	4.5	6.1	7.7	10.5
1989	7.2	9.5	7.0	7.0	7.2	9.5	13.5	22.5
1988	9.0	9.4	7.8	7.8	9.0	9.4	13.4	20.6
1987	8.9	10.3	8.6	8.6	8.9	10.3	13.1	14.9
1986	8.7	8.3	7.5	7.5	8.7	8.3	9.9	9.7
1985	8.4	7.6	7.5	7.5	8.4	7.6	9.0	6.2
1984	8.0	7.6	7.5	7.5	8.0	7.6	8.2	4.6
1983	7.6	6.3	6.8	6.9	7.6	6.3	6.2	3.3
1982	7.0	5.4	5.9	5.9	7.0	5.4	4.5	2.9
1981	6.2	4.3	5.3	5.3	6.2	4.3	3.4	2.3
1980	5.3	3.6	4.4	4.4	5.3	3.6	2.5	0.8
1979	4.6	2.4	3.2	3.2	4.6	2.4	1.5	0.5
1978	3.9	3.0	3.8	3.8	3.9	3.0	1.3	1.3
1977	3.2	2.8	3.6	3.6	3.2	2.8	1.1	0.0
1976	2.5	2.6	3.4	3.4	2.5	2.6	1.0	0.0
1975	1.8	2.4	3.2	3.2	1.8	2.4	0.8	0.0
1974	1.2	2.2	3.0	3.0	1.2	2.2	0.7	0.0
1973	0.8	2.0	2.8	2.8	0.8	2.0	0.6	0.0
1972	0.6	1.8	2.6	2.6	0.6	1.8	0.5	0.0
1971+Older	0.6	1.6	2.4	2.4	0.6	1.6	0.4	0.0
VMT Percentage of Total Vehicle Population[b]	72.9	7.7	4.6	4.2	5.7	0.7	3.3	0.9

Source: (Kircher, 1984)

a Each column (representing 1 vehicle type) totals to 100% and shows estimated vehicle registration (on July 1) by model year for each vehicle type.

b Final row shows percent of that vehicle type (in miles traveled) to total vehicle fleet (estimated miles traveled for all vehicle types).

Vehicle types are:

LDGV - Light-duty gasoline vehicles
LDGT1 - Light-duty gasoline trucks with Gross Vehicle Weight (GVW) <6001 lbs
LDFT2 - Light-duty gasoline trucks with GVW from 6001 lbs to 8500 lbs
HDGV - Heavy duty gasoline vehicles (trucks >8500 lbs)
LDDV - Light-duty diesel vehicles
LDDT -Light-duty diesel trucks
HDDV - Heavy-duty diesel vehicles
MC - Motorcycles

Table 6-8. MOBILE3 CO emission factors for 1990 as a Function of vehicle speed (grams/vehicle-mile)

Speed (mph)	CO Emission Factor	Speed (mph)	CO Emission Factor
5	110.74	31	28.07
6	101.63	32	26.88
7	94.06	33	25.75
8	87.63	34	24.68
9	82.06	35	23.68
10	77.15	36	22.73
11	72.76	37	21.85
12	68.80	38	21.01
13	65.19	39	20.23
14	61.88	40	19.50
15	58.82	41	18.82
16	55.97	42	18.19
17	53.31	43	17.60
18	50.81	44	17.05
19	48.46	45	16.54
20	46.24	46	16.07
21	44.14	47	15.62
22	42.14	48	15.21
23	40.25	49	14.82
24	38.45	50	14.45
25	36.73	51	14.09
26	35.10	52	13.74
27	33.55	53	13.38
28	32.07	54	13.03
29	30.67	55	12.66
30	29.34		

MOBILE3 Assumptions:

Low altitude Non-California Region
Ambient Temperature = 36°F
Non-catalyst Cold Start percentage = 18.4%
Catalyst Cold Start percentage = 18.1%
Catalyst Hot-stabilized Start percentage = 29.6%
Vehicle Age Distribution and VMT Vehicle Types given in Table X-A

vehicle emissions from roadways. No attempt was made to calculate air quality impacts due to link intersections because the information necessary (such as cycle time, queue lengths, green time for each approach lane, etc.) for such an analysis was not available. It is expected that good traffic engineering practices will minimize intersection impacts.

CALINE3 is a Gaussian dispersion model, with highway segments represented as a series of finite line sources positioned perpendicular to the wind direction. CALINE3 treats the region directly over the highway as a zone of uniform emissions and turbulence. This "mixing zone" is assigned an initial vertical dispersion due to mechanical turbulence created by moving vehicles and thermal turbulence created by hot vehicle exhaust. CALINE3 has the capability to model elevated highway sections (either fill or bridge types) and depressed highway sections, as well as the normal at-grade type of highway sections. For elevated or depressed sections, the height of the section above or below the local terrain is limited to a maximum of 10 meters.

CALINE3 requires input data as to the characteristics and dimensions of each traffic link. Links modeled for each project alternative are shown in Table 6-9. In CALINE3, roadways must be modeled as straight segments, not to exceed 10 kilometers in length. Therefore, some links were divided into smaller segments in order to approximate an irregularly shaped link or to restrict modeled links to 10 kilometers or less in length. Three meters were added to both sides of each link as required by CALINE3. This accounts for mechanical and thermal turbulence in the highway vicinity.

Traffic data for each proposed project site are shown in Table 6-9. The traffic data given in Table 6-9 consist of the estimated peak 1-hour traffic volumes for each traffic link modeled. These traffic volumes generally correspond to the evening rush hour. The traffic data for the peak 1-hour period, in addition to traffic volumes, also contains average vehicle speeds for each link. These speeds were used to assign MOBILE3 emissions rates to each link. These traffic data, along with CO emission factors, were input to CALINE3 for dispersion calculations at user-input receptors.

Receptors were placed along road links with large differences between project and no-project traffic volumes. These receptors were placed at a distance of 10 meters from the edge of the link mixing zone (or 13 meters from the edge of the nearest traveled lane) near the midpoint of the link being modeled. These distances are reasonable approximations of the edge of right-of-way boundaries. Receptors were not placed along every modeled link. Rather, emphasis in placing receptors was given to links with significant traffic changes between the project and no-project scenarios.

Table 6-9. Estimated peak 1-Hour traffic volumes and speeds in 1990 for Everett homeporting site.

	Roadway Width (feet)	Traffic Volumes/Speed	
		No Project	Everett Project
East Marine View Drive			
1) I5-Walnut	56	1020/25	2115/05
2) Walnut-Broadway	48	860/27	1955/05
West Marine View Drive			
3) Broadway-Alverson	24	860/32	2305/25
4) Alverson-13th St.	48	740/35	2185/25
5) 13th St.-19th St.	48	1070/30	2515/25
6) 19th St.-Everett	64	1010/30	1635/35
7) Everett-Hewitt	64	960/30	1440/30
8) Hewitt-Pacific	64	910/30	1270/30
Rucker Avenue			
9) Alverson-19th	42	405/25	425/25
10) 19th St.-23rd St.	42	570/30	675/30
11) 23rd St.-Everett	42	670/30	670/30
12) Everett-Hewitt	42	1110/30	1150/30
13) Hewitt-Pacific	42	1530/30	1650/30
14) Pacific-41st St.	76	2140/27	2515/25
15) South of 41st St.	60	2170/27	2440/27
Broadway			
16) North of Marine View	48	1910/40	2260/37
17) Marine View-16th St.	78	1820/35	1870/35
18) 16th St.-19th St.	78	1930/35	1980/35
19) 19th St.-Everett	78	1920/35	1925/35
20) Everett-Pacific	78	1920/35	1920/35
21) Pacific-41st St.	72	2250/32	2275/32
22) South of 41st St.	72	700/35	755/32
Interstate 5			
23) North of Marine View	94	5780/55	5780/55
24) Marine View-Hewitt	94	5900/55	6995/50
25) Hewitt-41st St.	116	5130/55	6060/55
26) South of 41st St.	116	7500/55	8430/50

Table 6-9. Estimated peak 1-Hour traffic volumes and speeds in 1990 for Everett homeporting site (cont.).

	Roadway Width (feet)	Traffic Volumes/Speed No Project	Traffic Volumes/Speed Everett Project
East Marine View Drive			
19th Street			
27) Project Site-Rucker	64	-	-
28) Rucker-Broadway	64	520/30	570/30
29) Broadway-Walnut	64	370/30	370/30
30) Walnut-I5	64	280/30	280/30
Everett Avenue			
31) Marine View-Rucker	64	800/30	820/30
32) Rucker-Broadway	64	1100/30	1100/30
33) Broadway-I5	64	1270/30	1270/30
Hewitt Avenue			
34) Marine View-Rucker	74	430/30	550/30
35) Rucker-Broadway	80	1180/30	1180/30
36) Broadway-I5	80	1350/30	1350/30
Pacific Avenue			
37) Marine View-Rucker	68	870/30	1230/30
38) Rucker-Broadway	68	1290/30	1315/30
39) Broadway-I5	72	1390/30	1390/30
Mukilteo Drive			
40) West of Federal	24	1240/30	1345/30
41) Federal-Rucker	24	1240/20	1345/20
State Route 2			
42) North I5 Ramp	24	2035/40	2120/37
43) South I% Ramp	24	2035/40	2120/37
44) East of I5 Ramps	68	4070/55	4235/50

Meteorological conditions modeled with CALINE3 consisted of an assumed atmospheric stability class E with a surface roughness length of 175 centimeters (cm). This scenario represents areas where the primary land use is office buildings in urban areas. Atmospheric stability class E represents stable atmospheric conditions (which occur only at night) and is the conservative stability class for calculating indirect source air quality impacts. Under stability class E conditions, vehicle emissions

experience only a limited amount of atmospheric dispersion before reaching the modeled receptors. A surface roughness of 175 cm is a reasonable assumption for urban areas (Benson, 1979).
Other meteorological inputs to CALINE3 were a windspeed of 1 meter/second (m/s) and an averaging time of 60 minutes and zero deposition and settling velocities (deposition/settling velocities are appropriate for particulate emissions only).

Because road links in the area have varying orientations, modeling calculations were made for each of 36 wind directions (10° to 360° by 10° increments). This was done in order to determine conservative conditions at each receptor. Conservative conditions near a given link are generally associated with winds approximately parallel to the link.

CALINE3 only predicts 1-hour pollutant concentrations. In order to estimate maximum 8-hour CO concentrations, procedures were used which have been researched primarily by Larsen. These procedures are based on the observation that maximum concentrations in a multi-source urban setting are proportional to the averaging time raised to an exponent. Hence, the maximum 8-hour CO concentration is equal to the maximum 1-hour CO concentration times a constant. Since the 8-hour to 1-hour ratio is strictly empirical background CO data for 1982 to 1983 for each study area were used for determining the 8-hour to 1-hour W ratio. These maximum measured concentrations were 18 ppm (1-hour) and 10 ppm (8-hour) for the Everett monitor near Hewitt Street, 22 ppm (1-hour) and 14 ppm (8-hour) for the 4th and Pike monitor in Seattle, and 17 ppm (1-hour) and 11 ppm (8-hour) for the Northgate monitor near Sand Point. Use of these measured concentrations give 8-hour to 1-hour CO ratios of approximately 0.56 for Everett, 0.64 for Seattle, and 0.65 for Sand Point. These ratios compare favorably with other reported ratios of 0.70 (Turner, 1970) and 0.60 (EPA, 1975).

For each project area studied, the majority of all project and nonproject traffic-related CO emissions were modeled. Since the preponderance of total area CO emissions is due to traffic, no background was added to the modeling results since "background" is already being modeled.

6.3.3. Mobile Source Modeling Results

Estimated maximum concentrations for each project area are shown in Table 6-10.

Table 6-10. Maximum concentrations (PPM) by receptor for Everett 1990 Project.

Receptor[a]	Everett Project A[b] 1-hr	8-hr
East Marine View Dr. (Walnut-Broadway)	11.8	6.6
East Marine View Dr. (Broadway-Alverson)	4.6	2.6
West Marine View Dr. (19th St-Everett)	2.5	1.4
West Marine View Dr. (Hewitt-Pacific)	1.8	1.0
Rucker Avenue (Pacific-41st St.)	4.7	2.6
Broadway (Marine View-Hewitt)	2.6	1.5
Interstate 5 (Marine View-Hewitt)	5.2	2.9
Interstate 5 (Hewitt-41st St.)	3.4	1.9
19th Street (Rucker-Broadway)	1.1	0.6
Everett Avenue (Broadway-I5)	2.1	1.2
Hewitt Avenue (Rucker-Broadway)	2.2	1.2
Pacific Avenue (Marine View-Rucker)	2.6	1.5
Pacific Avenue (Broadway-I5)	2.2	1.2
Air Quality Standards	46.8	26.2

a Receptor placed at mid-link 10 meters from edge of mixing zone (13 meters from edge of nearest traffic lane).

b Project alternative with Marine View Drive access to project site.

Estimated CO concentrations in Everett during 1990 with No Project Alternative are estimated to be well below the CO air quality standards of 35 ppm (1-hour) and 9 ppm (8-hour). Estimated concentrations along all links for Project Alternative A are predicted to be less than the CO standards, with highest

concentrations predicted in the vicinity of East Marine View Drive near the Broadway intersection to Interstate 5.

6.3.4 Mobile Source Modeling Scenarios

A second air quality analysis was also undertaken. This study compared three improvement options for West Marine View Drive. They are:

(1) An elevated roadway of 2 lanes and an at-grade roadway of 4 lanes between 19th Street and Everett Avenue. See Figures 6-2 and 6-3.

(2) A surface roadway consisting of 6 through-lanes and one left turn lane. See Figure 6-4.

(3) A surface roadway consisting of 4 through-lanes and one left turn lane. See excerpted Figure 6-5.

This analysis was performed using the previous screening study as a springboard of primary background information and methodology.

The Mobile 3 and CALINE3 prediction models are state of the art programs approved and recommended by the EPA. The modeling done for this comparison is a probable conservative scenario.

Many input variables are involved in composing an air quality study. Among these are grid layouts, receiver locations, wind rose angles, line link end points and traffic projections. These data categories are interpreted by the analysts. As a result, it is reasonable to expect some variation in results, when, as is the case here, different analysts evaluate the same given situations.

6.3.4.1. Carbon Monoxide

Beginning in 1982, the Washington State Department of Ecology and the Puget Sound Air Pollution Control Agency have published CO data from a monitoring station at 2005 Hewitt Avenue, Everett. During the monitoring period of 1982, 83, 84, and 85, the maximum one hour concentrations have been about half the 35 ppm standard. In this four-year period, the 8-hour measurements have exceeded the 8-hour average standard of 9 ppm per hour once in 1982, once in 1983, and once in 1985. Each exceedence was one ppm over the standard of 9 ppm. The NAAQS allows one exceedence of the CO standard per year, so there have been no monitored violations of the CO standard in Everett.

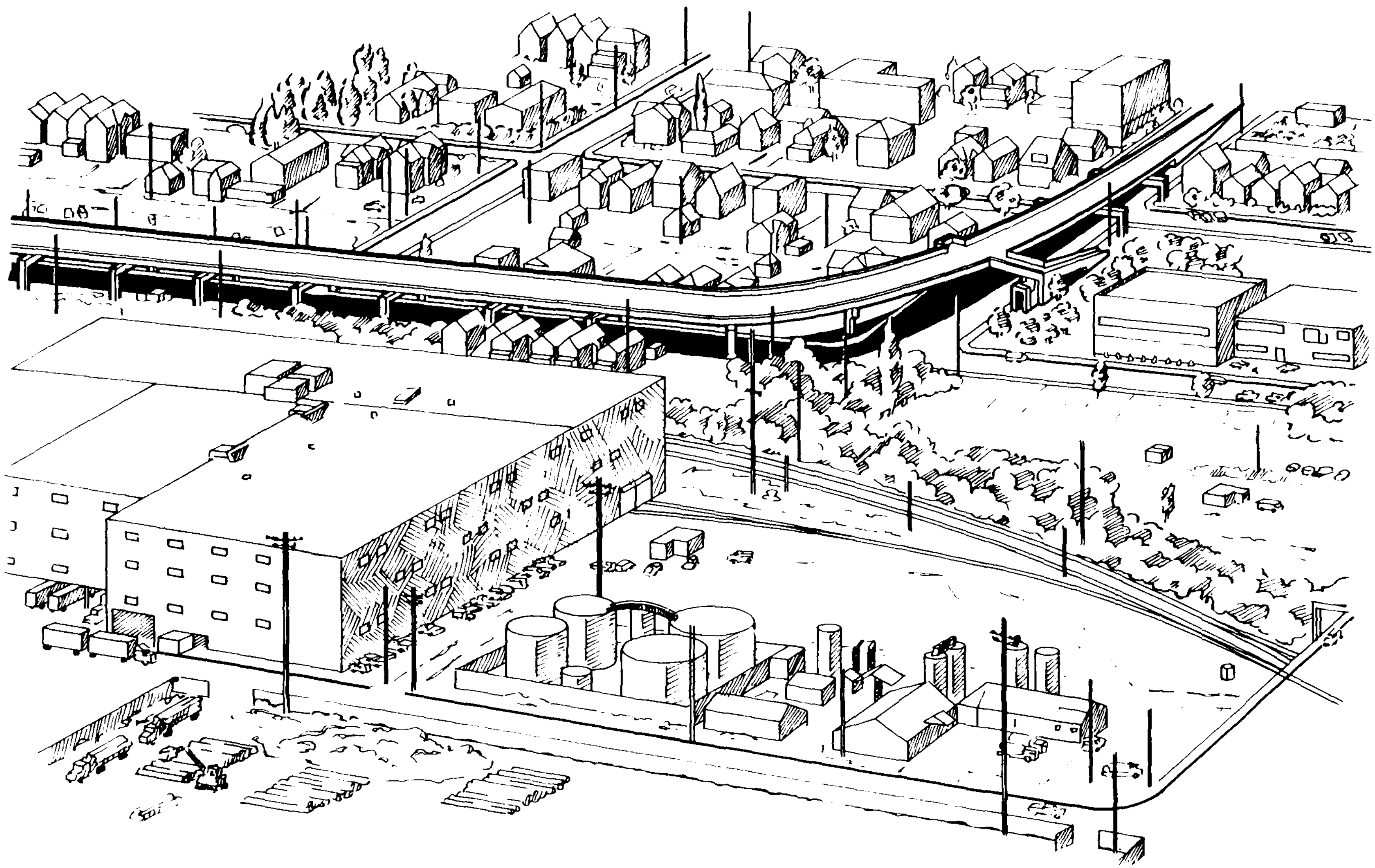


Figure 6-2.
Artist's rendition;
elevated roadway (south end).

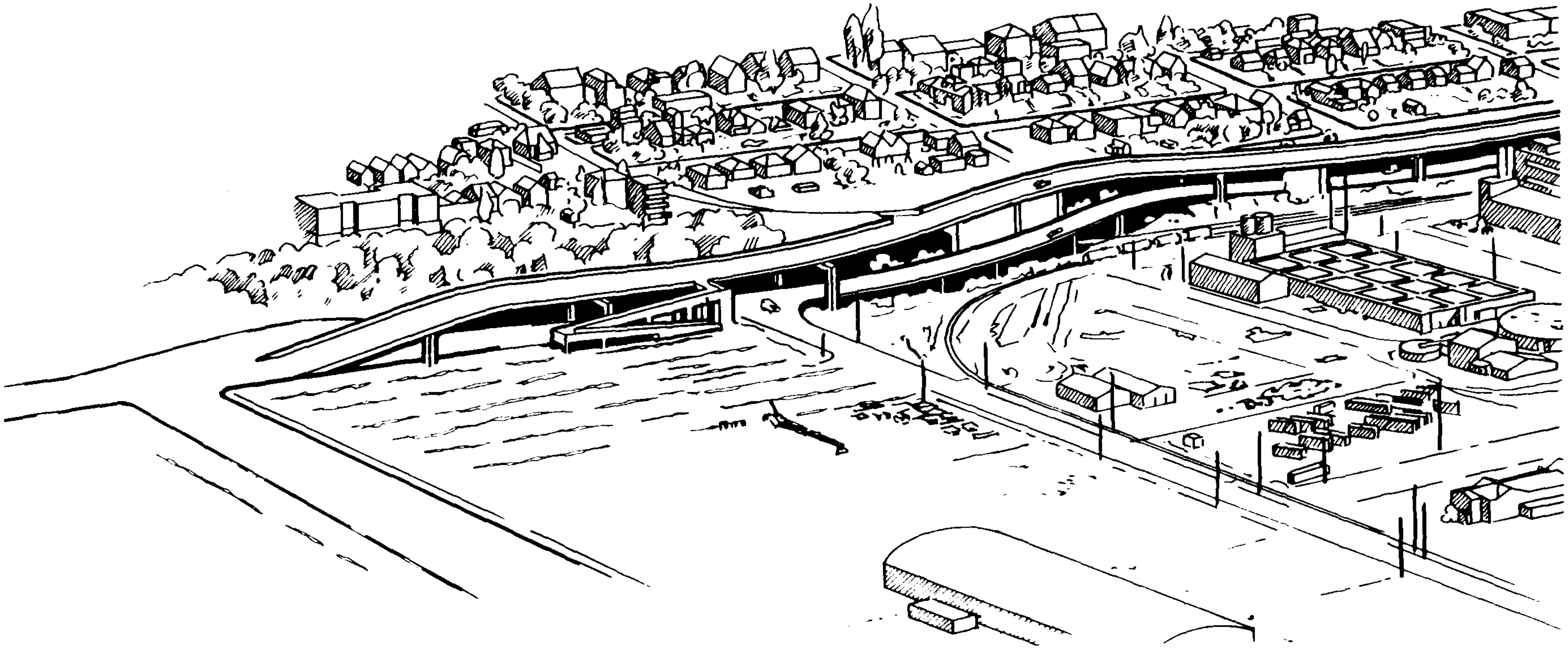


Figure 6-3.
Option A elevated roadway (north end).

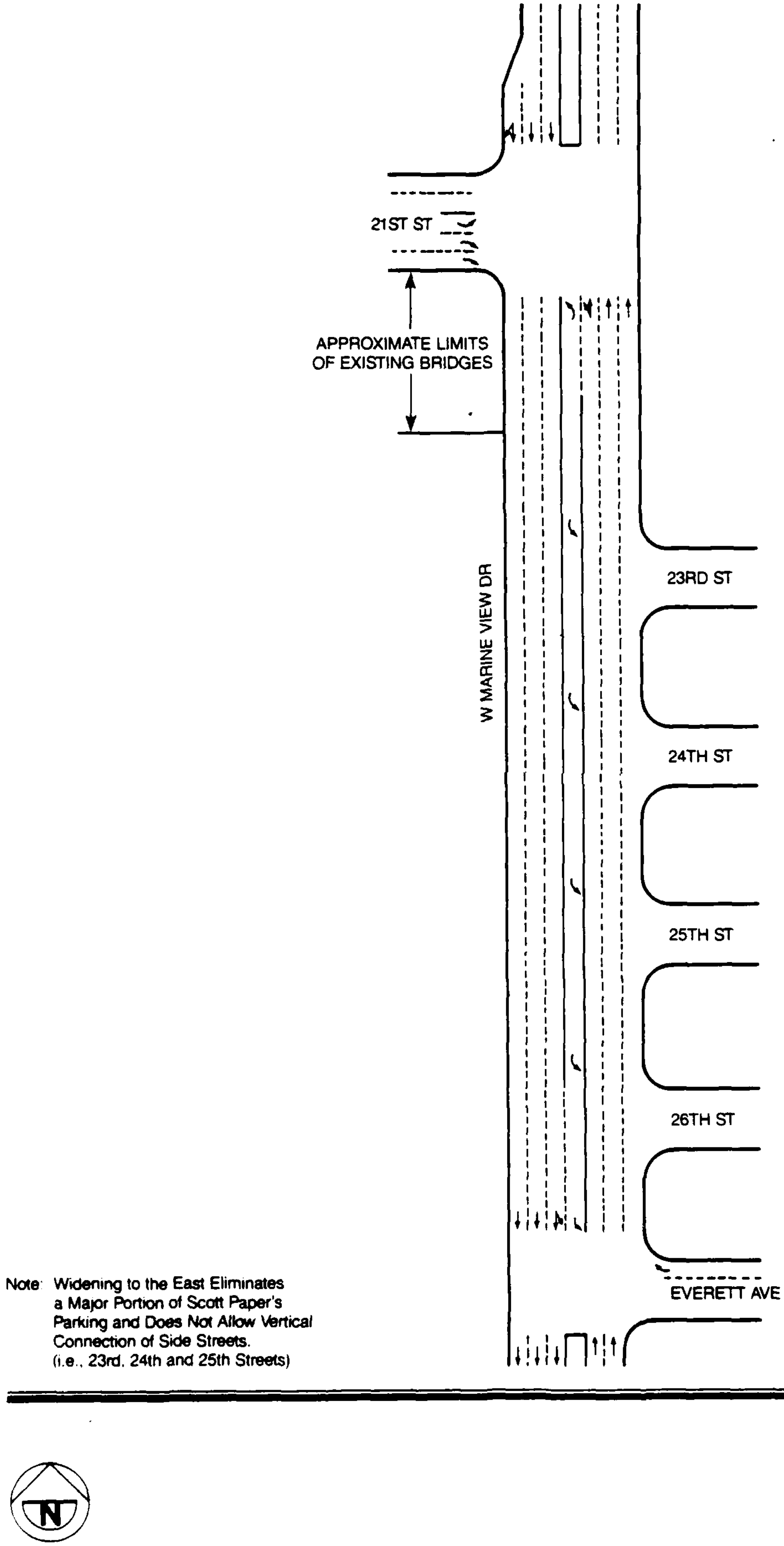
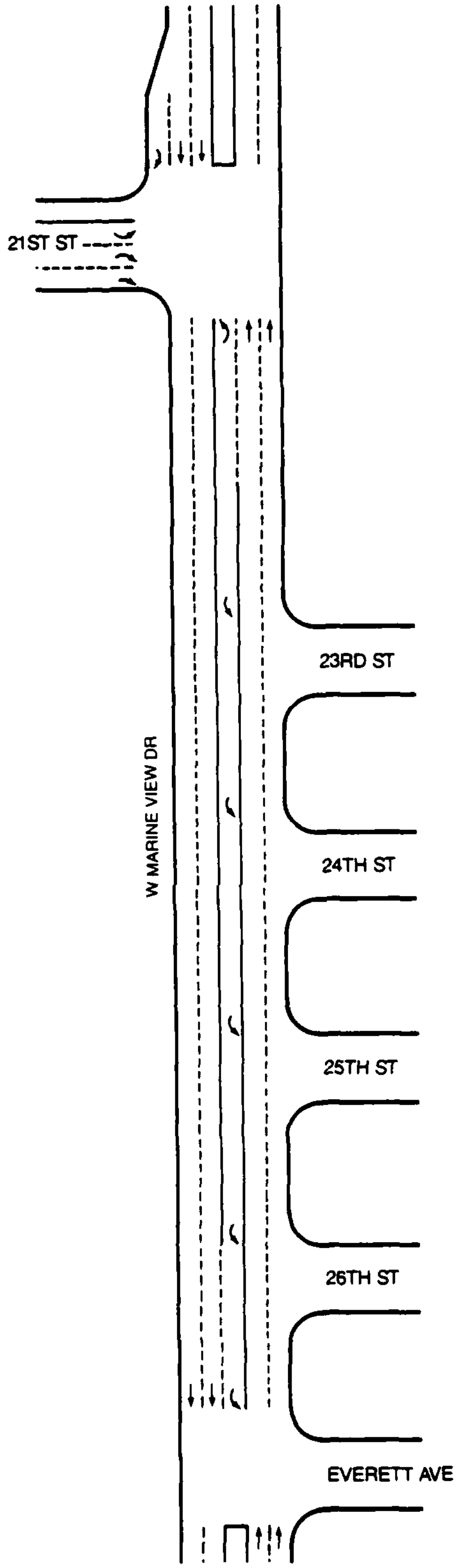


Figure 6-4.
Option B; seven lane surface road.



Note: This configuration Assumes the Widening of West Marine View Drive is Accomplished Entirely to the West. The Existing Retaining Walls On the East Side of West Marine View Drive Remain in Place. This Requires the Closure of the Nassau Connection to Scott Paper.

Figure 6-5.
Option C; Five Lane Road.

6.3.4.2. Air Quality Emissions Modeling

The modeling technique and technical data for the analyses are listed below:

(1) The Washington State Department of Transportation mainframe computer was used for calculation. The only apparent modeling change this could make is that the vehicle registration data may be slightly different than the previous study.

(2) The vehicle type percentages used are: LDGV 5.7, LDGT1 7.7, LDGT2 4.6, HDGV 4.2, LDDV 5.7, LDDT 0.7, HDDV 3.3, MC 0.9.

(3) Ambient temperature 36 degrees F used.

(4) No inspection and maintenance credits taken.

(5) Non-catalyst cold start used 18.4 percent
Catalyst cold start used 18.1 percent
Catalyst not-stabilized start used 29.6 percent

(6) Sixteen blocks of Marine View Drive and six blocks of Everett Avenue are modeled.

(7) The ten line links ranged from as short as one block to at most seven blocks.

(8) Receivers were located at the edge of the mixing zone, which is 3 meters from the nearest traveled lane.

(9) All wind direction angles of even 10 degree increments were used in the evaluation.

(10) 1990 traffic volumes, speeds and mixing cell widths are shown in Table 6-11.

(11) As recommended, an averaging time factor of 0.70 was used to adjust the maximum 1-hour carbon monoxide concentrations to maximum 8-hour average values.

6.3.4.3 Air Quality Impact Analysis

The results of the companion modeling techniques are shown in Table 6-12.

None of these options yielded a violation of the NAAQS. The wind angle which produced the highest concentration was from the north, 10 degrees west of north at 1 meter per second.

Table 6-11. 1990 traffic volumes, speeds, and mixing cell widths

	Mixing Zone Width	Vol/Spd
ELEVATED OPTION		
West Marine View Drive		
Wall St to Everett Ave (surface)	64	1529/20
Everett Ave to 19th St (surface)	68	2006/25
Everett Ave to 19th St (elevated)	44	1726/30
19th St to 14th St (surface)	68	1488/30
Everett Ave		
W Marine View Dr to Broadway (surface)	64	961/12
W Marine View Dr to Rucker (elevated)	44	827/12
7 LANE SURFACE OPTION		
West Marine View Drive		
Wall St to Everett Ave	92	2844/20
Everett Ave to 21st St	100	3732/25
21st to 19th St	104	3732/25
19th St to 14th St	68	1488/30
Everett Ave		
W Marine View Dr to Broadway	64	1788/12
5 LANE SURFACE OPTION		
West Marine View Drive		
Wall St to Everett Ave	80	2844/20
Everett Ave to 21 St	76	3732/20
21st St to 19th St	80	3732/20
19th St to 14th St	68	1488/30
Everett Ave		
W Marine View Dr to Broadway	64	1788/12

Table 6-12. Maximum CO concentrations (PPM) Everett 1990 project

Receptor	Predictions with Background 1-Hour	Predictions with Background 8-Hour
Elevated Option		
Midway between Everett Ave and 24th St	8.6	6.0
7-Lane Surface Option		
Midway between Everett Ave and 24th St	10.7	7.5
5-Lane Surface Option		
Midway between Everett Ave and 24th St	11.9	8.3

(1) Receptors are located 3 M from edge of roadway at mid-point in link.

(2) Conversion factor of 0.7 used to estimate 8-hour values from 1-hour predictions.

(3) Background assumed to be 2.0 ppm.

7. PORT OF EVERETT RELOCATION ACTIVITIES

7.1. Impacts of Port Facilities Relocation

In order to construct a homeport at the Norton Avenue Terminal site, it would be necessary for the Navy to purchase 96 acres of land from the Port of Everett in addition to the 21 acres already purchased from Western Gear. Current uses of the upland portions of this property are: a chill facility used to store perishable commodities, such as apples; a large graveled laydown area; several small general use structures; and a manufacturing plant previously owned by Western Gear Corporation (personal communication, Dennis Gregoire, 1986). The waterfront portion of the property includes several piers used for berthing of ships and yardcraft and other activities associated with the loading of logs from the water. A general description of the piers that would be acquired by the Navy is:

- Pier A - Destroyed by fire several years ago, only some piles remain.
- Pier B - A piling structure approximately 600 feet long. The north side is used for log loading. Berth depth is approximately 40 feet.
- Pier C - No longer functional.
- Pier D - A piling structure approximately 600 feet long that is used actively for log loading. Berth depth is approximately 40 feet.
- Pier E - A piling structure approximately 600 feet long that is used actively for log loading. Berth depth is approximately 40 feet.
- Norton Terminal Wharf - A marginal wharf approximately 1,100 feet long that has been used for shipping of commodities from the chill facility and some barge loading of lumber, modules, and various other commodities. Berth depth is approximately 32 feet.
- Graving Docks - Used at one time for barge loading of pipe for the Alaska pipeline.

The majority of current log loading operations at the Port of Everett are conducted by rafting logs into the East Waterway and

subsequently loading the logs directly onto the ship from the water. Piers B, D, and E are particularly important because they offer year round protection from the weather and longshore men can safely handle logs with few interruptions caused by rough water conditions. Substantial quantities of logs are stored in the East Waterway and at the end of the existing breakwater so that an ample supply of logs is available to continuously load onto the ships. Presently, it is common for up to 400,000 square feet of logs to be stored at the end of the breakwater and another 600,000 square feet to be stored in the East Waterway. Historically, these two log storage areas have been operated by two different towing companies and are generally not under Port adminstration.

Two other port facilities which also feature log loading activities would not be acquired by the Navy:

Pier 3 - South side used as a backup for log loading.

Pier 1 - South side usable for log loading on a limited basis because berth depth is only about 29 feet.

In 1983 the Port of Everett acquired property (referred to by the Port as Terminal 1) from the Weyerhaeuser Company that expanded the Port's holdings by roughly 40 acres. These facilities include a relatively new concrete marginal wharf (approximately 700 feet long) with covered storage and limited dock space and an older marginal wharf on pilings (approximately 525 feet long). For the most part, the Terminal 1 area is little used at this time.

Although the Port of Everett presently has no master plan for long range development, it has developed a strategy for maintaining services, especially log exporting. The Port's strategy for replacing the facilities that would be sold to the Navy was the basis for submitting a Section 10/404 permit application to the U.S. Army Corps of Engineers in June 1985. It should be noted that the Port of Everett submitted a revised Section 10/404 permit application to the U.S. Army Corps of Engineers in September 1986 which somewhat modifies the elements of Port relocation described below. The original strategy included the following elements that would take place in the sequence described below:

- Replace Pier B by using the north side of Pier 3 for log loading. Dredging would be required for this to take place.

- Replace Pier E with a new Hewitt Terminal finger pier. This pier would be 600 to 650 feet long and 50 to 80 feet wide and would have a berth for log loading on the north side. Dredging would be required to develop the berth.

- Replace Pier D by dredging the south side of Pier 1. For this loading area to be used effectively, the Navy's breakwater would need to be in place so that adequate protection from storms would be provided.

- Fill an inlet in the Terminal 1 area to replace upland storage and possibly provide an additional log and general cargo loading area.

- Redefine storage areas and operations in East Waterway so that approximately 1.5 million square feet of space is available for daily ship loading.

If the Port proceeds with its strategy, a number of issues will need to be resolved. For example, the proposed Hewitt Terminal finger pier would extend approximately 100 feet beyond the outer harbor line. The Port, then, must apply to the State Harbor Lines Commission to change the harbor line. In an earlier Section 10/404 permit application to the U.S. Army Corps of Engineers, the Navy commented that the length of the finger pier would restrict turning movements of Navy ships in the East Waterway. This matter is under review by the Port.

Secondly, the manner in which logs are stored in the East Waterway will also have to be coordinated with the Navy so that navigation channels are kept open and both ships and yardworkers are adequately protected. According to the Port's planning, there will be sufficient space available for storage of logs in the vicinity of East Waterway during loading operations after the homeport is in operation.

Movement of commercial vessels, yardcraft and logs would be particularly difficult during homeport dredging, since dredges must proceed in set patterns and cannot be readily moved for short periods of time without significantly increasing operational costs. Close coordination should be established between the Navy, their construction contractors, log towing companies, and the Port so that dredge sequencing in the East Waterway can be adjusted accordingly.

During the spring of 1986, the Port conducted a sediment sampling program to determine the extent of contaminated sediments in the material that would be part of their proposed dredging program. It was estimated that the Port's dredging project would require the removal of approximately 51,500 cubic yards of contaminated sediments and at least 170,000 cubic yards of clean sediments. Removal of contaminated sediments would add to the East Waterway cleanup program that would result from the Navy's proposed homeport dredging. Depending on the timing of the Port's dredging program and the capacity of the Navy's dredge disposal area, coordination of dredge disposal activities could take place. Separate environmental documentation would be

required for dredging, dredge disposal, and construction associated with the development of new Port facilities.

7.2. Impacts of Dredge Disposal

Of the various Homeport dredge disposal options, only two would have significant impact on Port activities. Nearshore disposal at the north end of East Waterway would decrease the area available to both the Navy and the Port and would have a limiting effect on the Port's ability to store logs while loading ships. The Snohomish Channel disposal option would result in the loss of up to 180 acres of privately owned log storage area. While in some cases log storage areas could be used more efficiently and shipments of logs to the Everett area could be more closely coordinated so that logs were held for a shorter period of time, additional log storage may be required. An upland log storage area could be built on the site after it was filled or other areas near Jetty Island or the estuary could be sought for storage. Any new area would be adversely impacted by bark and other debris associated with log handling. Specific impacts would depend on the location of the new log storage area.

7.3. Western Gear Corporation Closure

Western Gear Corporation was located on a portion of the property that the Navy has acquired. The firm was engaged in the manufacture of equipment for petroleum exploration and mining and a variety of other types of heavy equipment. Western Gear employed approximately 350 workers.

Although several proposals had been made that would have offered Western Gear an opportunity to relocate in the Everett area, Western Gear has decided to close its Everett operation. This closure will result in a loss of 350 jobs as well as the tax revenues associated with the firm's operations.

8. NATIVE AMERICAN CONCERNS

This supplemental environmental impact statement provides additional information and analysis beyond that which was discussed in the Draft and Final EIS. The U.S. Army Corps of Engineers formally adopted on 9 July 1986, the Navy FEIS which extensively documents Tribal concerns, impacts and U.S. Trust responsibilities (see FEIS Volume 1 Text Chapter IV, pp. 136-151; pp. 154-156; pp. 258-263; Chapter VI Response to Comments and Appendix Q, pp. Q-1 - Q-80). This document, prepared in accordance with National Environmental Policy Act Regulations, discusses in greater detail those impacts to the physical and natural environment associated with the homeport project, specifically dredge disposal sites and methods.

8.1 Treaty Tribes

The Treaty Tribes of Washington are officially recognized by the United States government as retaining inherent tribal sovereign governing powers within their territories. These powers are exercised in accordance with the Tribe's constitution and bylaws, adopted pursuant to the Indian Reorganization Act of 1934. With this status, the Tribes have civil and criminal jurisdictional powers and immunities within their territory.

There are 18 Puget Sound Treaty Tribes that are recognized as sovereign governing powers with fishing rights at all "usual and accustomed grounds and stations" in Puget Sound and Strait of Juan de Fuca.

The location of reservations of these 18 Treaty Tribes can be found in Figure IV-25 of the Navy FEIS. Details of the locations of their usual and accustomed fishing areas are presented in Appendix Q of the navy FEIS. The primary Tribes in the area of the proposed homeport are the Tulalip Tribes, the Stillaguamish Tribe, the Lummi, the Muckleshoot Tribe, the Suquamish Tribe, and the Swinomish Tribal Community. Of these, the Tulalip Tribes are the primary and dominant tribe in the vicinity of the proposed Everett Homeport facility.

The Treaty of Point Elliott secured the Tulalip Tribes and the Stillaguamish Tribe the right to "take fish at usual and accustomed grounds and stations . . . in common with all citizens of the territory." The United States Supreme Court has held that this right guarantees access to designated fishing grounds, and secures the Indians a meaningful opportunity to take up to 50 percent of the harvestable anadromous fish runs destined for or passing through those grounds, as needed to provide them with a moderate standard of living.

Further discussion of Tribal rights and issues of concern, including impacts to the Tulalip Tribes in the areas of land use, economy, demographics, housing and treaty fishing rights are presented in the Navy FEIS.

8.2 Trust Responsibility

The Courts have held that a trust relationship exists between the Federal government and Indian tribes with respect to Indian fishing rights created by treaty. That trustee responsibility applies to the regulatory authority discharged by the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act and Section 10 of the River and Harbor Act. In the role of trustee, the U.S. Army Corps of Engineers has affirmative duty to protect treaty fishing rights when making regulatory decisions.

It is recognized that this project would adversely affect treaty rights as discussed in the Navy FEIS. Should the Navy and the Tribe reach mutual agreement regarding the fishing rights issue, the U.S. Army Corps of Engineers would take that agreement into account in discharging its responsibilities, including the trust responsibility. If the Tribe and the navy do not reach agreement, the U.S. Army Corps of Engineers will be required to deal with the issue independently. The U.S. Army Corps of Engineers would then decide whether Tribal fishing rights can be adequately protected through conditioning the Section 10/404 permit or mitigation. If so, it may be possible to issue a permit which incorporates appropriate conditions. If not, the permit would be denied.

8.3 Navy and Tribal Negotiations

The Navy Homeporting Office reports steady improvement in the relationship between the Navy and the Tulalip Tribes since the Tribes sought early recognition of potential impacts of the homeport during the site selection process. The Navy initially limited its interaction with the Tribe to correspondence, then began a series of periodic meetings which led to complex discussions with the Tribes regarding mutually cooperative efforts. The expressed frustration of the Tribe at the lack of recent negotiations progress is both understood and regretted by the Navy. While there has been significant progress to date between the Tribe and the Navy, there is no agreement in place between the Navy and Tulalip Tribes regarding Homeport related tribal impacts.

Initially, the Tribe sought recognition and respect for its sovereign status, traditions, economic conditions and natural resources in the vicinity of the homeport. The Navy has consistently meet with the Tribe and, in good faith, sought to agree to conditions that would be mutually beneficial to both parties. The Tribe has participated in numerous coordination meetings on

the homeport development process allowing the Tribe to directly input its concerns on project impacts, studies, and other related activities.

In addition, the Navy and Defense Departments supported the Tribe's application to the Department of Commerce (Economic Development and Administration) and Department of Defense (Office of Economic Adjustment) for a planning grant, which has resulted in the Tribe receiving a $65,000 grant in 1984. Further, the Navy provided the Tribe with funds totaling $97,000 to study salmon migration patterns during the March-August 1986 period.

With respect to Federal policies aimed at promoting Tribal economic development, the Tulalip Tribes were invited to participate in a series of working meetings regarding "How to do Business with the Navy" which culminated in a widely publicized brochure and a seminar held on 18 June 1986 to explain the Navy's procurement regulations and need for services and supplies. The Tribe can now decide what types of business development activities it should undertake to take advantage of commercial opportunities identified in the Snohomish County Economic Development Council's report entitled <u>Navy Business Opportunities in Snohomish County</u>, dated September 1985.

8.4 Areas of Concern

The U.S. Navy Homeport site proposed for Everett Harbor is within Marine Fish Reporting Area 8 as defined by the Washington Department of Fisheries. The Tulalip Tribes describe the Snohomish River basin, portions of Area 8 (including the proposed Homeport site), and portions of Area 9 as "usual and accustomed fishing areas" of the Tribes (Figure IV-25 of the Navy FEIS). The Stillaguamish River basin, including the north and south forks, are recognized as "usual and accustomed fishing areas" of the Stillaguamish Tribe. In addition, the Stillaguamish Tribe has invitational fishing rights in Area 8 (Williams, R., personal communication, 1985). The Tulalip Tribes are recognized as fishery resource managers within Area 8, with the Stillaguamish Tribe participating as co-managers. Stillaguamish Tribal fishermen commercially fish marine waters in portions of Area 8 (at the invitation of the Tulalip Tribes) including areas near the proposed project, however, Tulalip Tribal fishermen are the primary treaty fishermen commercially fishing in Area 8 (Williams, R., personal communication, 1985). The Tulalip Tribes and Stillaguamish Tribe, under the Treaty of Point Elliott and upheld by the 1972 Boldt decision, are assured the opportunity to catch 50 percent of the harvestable portions of salmon and steelhead runs passing through or originating from usual and accustomed fishing grounds. Fish are also harvested for ceremonial and subsistence purposes within the Tulalip and Stillaguamish usual and accustomed fishing areas. In addition to the adjudicated usual and accustomed fishing area, the Tulalip

Tribes also exercise marine fishing rights in waters of the San Juan Islands. The Tulalip Tribes participate as resource co-managers within Areas 6, 6A, 7, 7A, 8, 9 and 10.

A thorough discussion of tribal salmonid enhancement plans and commercial fishing practices in the Port Gardner area presented in the Navy FEIS.

Of concern to Tulalip and Stillaguamish Indian Fishermen with respect to the preferred alternative is: 1) the reduction in fishable area within their usual and accustomed fish grounds resulting from proposed Homeport pier construction; 2) increased potential for fishing gear damage and/or reduced fishing time resulting from additional Homeport related ship traffic in Port Gardner and Possession Sound; and 3) potential degradation/alteration of salmonid and Dungeness crab habitat and water quality associated with construction and operation of the proposed project.

Chapters 4 and 5 of this document discuss impacts to water quality and fishery resources including Dungeness crab resources associated with dredging and dredge disposal. Additional impact analysis related to fishery resources, water quality and commercial fishing operations are provided in the Navy FEIS. The following paragraphs address specific concerns of the Tulalip Tribes and Stillaguamish Tribe associated with the homeport project and dredging and dredge disposal.

Organotin Paint. The Navy has set preliminary criteria for the release rate of .15 ug/cm^2/day Tributyltin (TBT). Formulations of organotin paint would be tailored to achieve that rate. The tables included in the DEISS clearly present the toxicity of TBT in seawater. Details of experimental designs and conditions, chemical properties and biological pathways are all taken into account when EPA sets criteria for chemicals released into the environment. The Navy will only use EPA registered paint formulations and will not exceed EPA criteria. Should EPA criteria fall below the Navy's present target concentration, formulations will be adjusted accordingly to comply. The predicted concentrations for East Waterway were calculated using the Tidal Prism Method (Ketchum 1951a, 1951b).

Graywater Discharges. Water quality measurements made by WDOE (1980-1985) and by Parametrix (1985) are presented in Appendix J of the Navy FEIS. Dissolved oxygen is included in that data and reflects the result of current 5-day BOD and 5-day COD loading into East Waterway. Using the Tidal Prism Method, a dilution of 660 fold is predicted to occur in the plume in 24 hours. If TOD (BOD + COD) is divided by 5 (these are 5-day measurements) and by 660 (dilution factor), the resulting predicted dissolved oxygen depression equal 0.25 mg/L. Since the mean particulate residence time was calculated to be 15 hours in East Waterway, analysis

past 24 hours is irrelevant. Water quality criteria for East Waterway (Class B water) established by WDOE states that "dissolved oxygen shall exceed 5.0 mg/L". The lowest observed dissolved oxygen concentration at the surface in East Waterway (graywater is less dense than seawater) is 5.3 mg/L. The resultant conservative dissolved oxygen level would then be 5.05 mg/L. Other than that one measurement of 5.3 mg/L, dissolved oxygen measurements for four years ranged from 7.1 to 13.3 mg/L with a mean of 9.3 mg/L (Navy FEIS, Appendix J, 1985). However, current Navy plans include the development of a graywater retrofit schedule with the state of Washington.

Fuel Facilities. The ability to top off ships in their berths in Everett was determined by the Navy to be more desirable from an operational, readiness, and vessel traffic and safety standpoint than fueling at Manchester. Additionally, the Nimitz cannot be handled at Manchester. Barge to vessel transfer was determined to be more costly than land-based (wharf) facilities at Everett.

The proposed location of the fuel transfer dock in the river mouth was chosen for a number of reasons. The cost would be lower since an existing wharf is utilized. This also lowers the amount of in-water construction needed to build a new wharf in the East Waterway. The East Waterway is more congested with ships, boats, and traffic. At the present, the Navy is reanalyzing the feasibility of moving the fuel transfer dock to the East Waterway to see if this can occur without interference with commercial shipping and without compromising any future expansion plans at the Norton Terminal site.

Cumulative Impacts. The potential cumulative impacts of project operation are noted in Chapter 5 of the FEISS. However, because the synergistic and antagonistic effect(s) of various pollutants is unknown, quantification and cumulative assessment of such impacts is not presently possible. Removal of the presently contaminated sediments in East Waterway is expected to result in at least temporary enhancement of water quality. However, ongoing discharge of contaminants from the point and non-point sources adjacent to East Waterway may be expected to result in adverse impacts. Also refer to the discussion in Section 4.6 of the Final EISS. In addition, Chapter 4 of FEISS notes, in terms of cumulative impacts, the additional volume of contaminated sediments contributed by the Port of Everett development during dredge and disposal activities would not be expected to increase the relative magnitude of event related water quality impacts over those previously described. It would, however, extend the duration of such impacts during the extra time required for the additional dredge and disposal activities. Based on the additional dredge material estimated for the Port of Everett, this would amount to an increase of approximately 6 percent.

Maintenance Dredging. Maintenance dredging is anticipated to occur as a result of normal operations at the proposed facility. Such future activities will require an assessment of environmental impacts as part of the permitting process and, therefore, will be addressed at that time.

Dungeness Crab. As a result of the resource agency and Tulalip Tribe's concern related to Dungeness crab resources, the Navy has identified a new preferred alternative disposal site. This site, Revised Application Deep or RAD CAD has been located to minimize long-term impacts to the Dungeness crab resource of Port Gardner. A conservative impact assessment of each CAD site with respect to Dungeness crab is presented in Chapter 5 of the FEISS.

The concentrations of Dungeness crab identified at the Deep Delta and other specific locations within Port Gardner may be the result of biological attractions such as rearing and spawning habitat or physical features such as depth, slope, proximity to the Snohomish River mouth, substrate type, debris, etc. While the Tulalip Tribes are concerned debris may be a habitat requirement for crab, the site specific information available (Dinnel et al. 1986 A, B and C) do not indicate an observed correlation.

The survival of Dungeness crab buried as a result of dredge disposal is of concern, but currently unknown. As such, it cannot be assumed all crabs within the dredge material deposition area will be smothered or damaged. To facilitate a conservative impact analysis, however, the Dungeness crab impact assessment presented in Chapter 5 assumes 100 percent mortality for all crabs (egg-bearing and non-egg bearing) in the deposition zone.

The extent to which the homeport project will affect Dungeness crab resources and thereby impact the Tulalip Tribes, is a topic of discussion in the negotiations between the Navy and the Tribes.

Juvenile Salmonids. The March 15 to June 15 "fish window" established by the Washington Department of Fisheries (WDF) will be observed by the Navy for avoidance of significant impact to the juvenile salmonid resource. The presence of juvenile salmonids in the marine waters of Port Gardner and Port Susan after June 15 was documented in a recent Snohomish River outmigration study (Tulalip Tribes 1986). Dredging impacts to juvenile salmonids present in the East Waterway vicinity after June 15 will be minimized due to the pelagic nature of the fish and the fact that they will have reached a sufficient size to avoid the majority of the impacts.

9. TRAFFIC AND TRANSPORTATION IMPACTS

In August 1986 Puget Sound Council of Governments (PSCOG) published a traffic impact report that updates the traffic impact analysis contained in the EIS. The PSCOG report differs from the prior analysis in that it calculates impacts for a 13 ship battle group rather than a 15 ship battle group as was done in the prior analysis.

The key findings of the PSCOG report are:

1) 1990 background traffic growth (projected conditions without the Homeport) is expected to vary from modest on Everett arterials serving primarily local traffic to intermediate on arterials providing access to Interstate 5 and SR2 to relatively high (16 to 25 percent between 1983 and 1990) on the regional highways themselves.

2) Generally the Everett arterial system can accommodate the 1990 background traffic growth while still maintaining Level of Service (LOS) A conditions, except on Broadway where an LOS C/D would be expected at major intersections during the PM peak hour.

3) 21,800 vehicle trips per day would be generated by the Homeport under "conservative" conditions (for a 13 ship battle group). "conservative" conditions are defined in the PSCOG report to be when the Carrier Battle Group (CBG) is preparing for deployment and the Destroyer Tender is in port.

4) Of the traffic generated by the Homeport under these "conservative" conditions 11.4 percent, or 2490 vehicle trips, would occur during the PM peak hour and 10.6 percent, or 2310 vehicle trips, would occur during the AM peak hour.

5) About 16 percent of the daily traffic generated by the Homeport would use the north access corridor and 84 percent would use the south access corridor. For the PM peak hour the respective shares are 22 and 78 percent.

6) Under the "conservative" conditions described above, traffic would increase by 100 percent or more on Marine View Drive between the Navy access and Pacific Avenue and also on Everett and Hewitt Avenues between Marine View Drive and Rucker Avenue. The average percent increase in 1990 traffic volumes for heavily impacted road segments is shown below.

West Marine View Drive	
Navy access road to Everett Avenue	191%
Everett to Hewitt	163%
Hewitt to Pacific	126%
North of the Navy Access Road	39%

<u>Pacific Avenue</u>	
West Marine View Drive to Rucker	93%
Rucker to Colby	63%
Colby to Broadway	41%
<u>Everett Avenue</u>	
West Marine View Drive to Rucker	136%
Rucker to Colby	42%
Colby to Broadway	18%
<u>Hewitt Avenue</u>	
West Marine View Drive to Rucker	112%
Rucker to Colby	42%
Colby to Broadway	22%
<u>Rucker Avenue</u>	
Everett to Hewitt	10%
Hewitt to Pacific	20%
Pacific to 37th	23%
37th to 41st	18%
<u>Broadway</u>	
Pacific to 37th	15%
37th to I-5 Interchange	20%
<u>37th Street</u>	
Rucker to Colby	30%
Colby to Broadway	25%

7) Under the "conservative" conditions described above there will be a reduction in LOS at virtually all intersections on the primary routes of travel. With existing geometry and traffic control, intersection capacities under these conditions would be exceeded at four locations: on Marine View Drive at Everett Avenue and at Pacific Avenue and on Broadway at Pacific Avenue and at 37th Street. In addition, Marine View Drive at the Navy access would be at capacity with a three-lane exit from the base.

8) At the five intersections described above, additional lanes or reconfiguration of the existing roadways would be required to provide an acceptable LOS. A five-lane roadway on Marine View Drive would raise the operation of all the existing intersections on that arterial to LOS B with Homeport traffic. Adding an eastbound to southbound right turn lane at Broadway and Pacific Avenue would raise the operation of that intersection to LOS D with Homeport traffic. At Broadway and 37th Street, providing three eastbound lanes (left turn, through/right, and right turn) from 37th Street and also a right turn lane southbound to eastbound would raise the operation of that intersection to LOS D with Homeport traffic.

9) If only one gate is provided at the Navy facility, three lanes outbound at the intersection with Marine View Drive would be required to accommodate the PM peak hour traffic. At least three lanes northbound on Marine View Drive would be required to accommodate the AM peak hour traffic. With this geometry this intersection would operate at LOS D/E during the respective peaks.

Negotiations are currently ongoing between the Navy and the City of Everett to determine the final access option and related funding strategies.

10. POPULATION AND HOUSING

No additional information on population and housing has been developed since the distribution of the DEISS.

11. NUCLEAR CONCERNS

This section assesses the radiological environmental effects of Naval nuclear propulsion plants. The fact that radioactive material is an inherent byproduct of the nuclear fission process makes the proper control of the Navy's nuclear propulsion program a matter of environmental concern. This concern was recognized at the inception of the program and all features of design, construction, operation, maintenance and personnel selection, training and qualification have been oriented towards minimizing environmental effects and ensuring the health and safety of workers, ships crew members, and the general public.

Normal Operations

The Navy issues an annual report which describes the Navy's policy and practices regarding such things as disposal of radioactive liquid, transportation and disposal of radioactive materials and solid wastes, and monitoring of the environment to determine the effect of nuclear-powered warship operations. This report is provided to Congress and to cognizant federal, state and local officials in areas frequented by nuclear-powered ships. The conclusions of this report can be applied directly to Naval nuclear-powered ships homeported at the Everett, Washington site. The procedures that will be followed by these nuclear powered ships in Everett are no different from those followed by nuclear-powered ships homeported elsewhere. Ship refuelings will not be conducted in Everett. The latest report NT-86-1, "Environmental Monitoring and Disposal of Radioactive Wastes from U.S. Naval Nuclear Powered Ships and Their Support Facilities", was attached as Appendix F of the Draft EISS (DEISS). The results contained in Appendix F demonstrate that the homeporting of Naval nuclear powered ships at the Everett, Washington site should have no significant radiological environmental effect and no adverse impact on the health and safety of the public.

Additionally, environmental monitoring, consisting of harbor water and sediment samples, marine life samples, air samples and shoreline radiation surveys, will be performed prior to the arrival of nuclear powered ships at Everett and periodically thereafter. This preoperational survey will provide adequate baseline data so that the results of monitoring subsequent to the arrival of nuclear powered ships can be compared to verify the absence of any significant radiological environmental impact. The environmental monitoring program at Everett will be similar in scope and frequency to existing programs at the Puget Sound Naval Shipyard in Bremerton and the Trident Refit Facility in Bangor, Washington; the results will be published annually in the Navy report cited above.

The design and operation of Naval nuclear powered ships result in minimal risk of accidents while in port and low consequences should a problem occur. First of all, a naval reactor is rated at only a small fraction of the power of a commercial nuclear central station power plant. Second, ships are in port only a fraction of the time. The normal condition of the reactor when they are in port is to be shutdown or operating at very low power levels. Third, changes in these plant operating conditions are routine evolutions since the plants are designed to accommodate significant transients as would be expected for a plant that must be able to respond to the variable demands of warship propulsion. Fourth, these plants must also meet stringent military requirements for shock and battle conditions and are installed within strong hulls which must also meet stringent military requirements. Fifth, the operators of naval nuclear reactors are carefully selected, qualified and trained to perform under the most adverse conditions. Finally, the mobility of the ships provides for the removal of the problem source in the unlikely event of an accident.

The strict adherence to conservative principles of design and operation of naval reactors was discussed on May 24, 1979, by the Director of the Naval Nuclear Propulsion Program (then Admiral H.G. Rickover) in Congressional testimony following the accident at Three Mile Island. Admiral Rickover emphasized that ensuring reactor safety is the responsibility of all personnel who work on naval nuclear propulsion plants and that each element from training, to design, to construction, and to operation must be properly carried out in a coordinated fashion to achieve the goal of safe performance.

The Navy's record in ensuring the safe design and operation of nuclear propulsion plants is illustrated by the fact that naval reactors have accumulated over 3,000 reactor-years of operation without a reactor accident or any other problem having a significant effect on the environment.

<u>Abnormal Operations</u>

An analysis of reasonably foreseeable events has been completed and cited in Appendix F of the DEISS, pages 26 through 31. This analysis was performed for an assumed release at Naval shipyards including the nearby Puget Sound Naval Shipyard. Since Everett is close to this shipyard and has similar meterological and demographic characteristics, the analysis is judged applicable to the proposed homeport. The analysis demonstrates that an assumed release of reactor coolant containing the radionuclides cited in Appendix F of the DEISS, Table 5 will have no significant impact on the environment. It should be noted that the assumed release represents the release of several thousands of gallons of water from a Naval nuclear propulsion plant which is far more than would be expected by foreseeable operations, collection tank

ruptures and the like. The analysis is therefore conservative in that regard.

Pages 9 through 11 of Appendix F of the DEISS also contain information on the environmental impact of ship sinking accidents which have occurred. Additional information on these accidents is contained in the Final Environmental Impact Statement on the Disposal of Decommissioned Defueled Naval Submarine Reactor Plants, May 1984, which has been incorporated by reference into the EISS. As noted in both Appendix F and the above-referenced FEIS, only low levels of corrosion product radionuclides exist in the sediments and these are confined to the immediate area of the sunken ships. None of the samples showed any evidence of release of radioactivity from the reactor fuel elements. The amount of radioactivity found in the sediments is comparable to the value used in the release analysis noted above which has already been shown to have no significant environmental impact. It is therefore concluded that a ship sinking accident at Everett, even under the most destructive of circumstances as occurred with submarines exceeding test depth, would, by extension, have no significant environmental impact on the radiological quality of the environment.

Emergency Planning

Background

The Navy provides for coordinating with state and local government authorities within the United States and its territories concerning radiological emergency preparedness in support of assigned operations in accordance with Department of Defense (DOD) policy. Where the potential exists for an accident involving radioactive materials associated with a Naval Base, planning considers the safety of the general public as well as Naval personnel. When the general public might be affected, an appropriate level of coordination with State and local governments is conducted on a site specific basis. This approach is also used at the Trident Refit Facility in Bangor, Washington.

Guidance for State and local emergency preparedness has been developed for commercial nuclear power plants ("Criteria for Preparedness and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" NUREG-0654/FEMA-REP-1, November 1980). This commercial facility guidance document is structured for a specific type of facility and the associated potential emergency situations and incidents that could occur at that type of facility. This document is not applicable to the Naval bases where nuclear powered warships are homeported owing to the differences between naval and commercial reactors described above, the military mission of the facilities and other considerations described below.

Navy implementation of the DOD policy for emergency planning is based on consideration of the following factors:

Navy ships are operated to high safety standards, and have a low potential for major radiological accidents.

Naval ships have special design features to prevent and mitigate the release of radioactivity despite the occurrence of severe casualties.

Naval ships are designed to very stringent military shock requirements, making the likelihood of any failure very small. A collision of a nuclear powered ship of this carrier battle group with another ship or structure while transmitting to or from Everett would not be expected to cause the release of radioactivity from the nuclear fuel.

The Navy has provisions for immediate and effective response to any emergency on the ship.

Extensive Federal emergency response resources, as outlined in the Federal Radiological Emergency Response Plan (FRERP), would be activated as needed in such an emergency to support State or local response. The FRERP has provisions for activation at any time.

Existing State and local government general purpose emergency response plans contain elements common to all accidents and, therefore, are as appropriate for dealing with radiological emergencies as with any other emergency.

State and local agencies do not need significant new capabilities for radiological emergency response solely as a result of the presence of the Naval ships. In fact, for a shipboard emergency, the only unique aspect is the identification of the actual radiological condition at the time of an accident which will be provided to State and local officials by Naval authorities.

If an actual emergency occurs, the Navy will assess the situation, evaluate any potential risk to the health and safety of its personnel and the general public, establish communications with State and local authorities to keep them informed of the emergency, and suggest appropriate protective measures, when necessary.

Time and radiological characteristics of a release, the area affected, and the appropriate protective actions depend on the particular accident and prevailing atmospheric conditions.

The Navy conducts periodic exercises to develop and maintain key response skills. These exercises include, to the extent practicable and appropriate and as permitted by security considerations, participation by State and local response organizations.

Direct Federal funding for specific State or local emergency preparedness efforts around Naval bases has been neither authorized nor appropriated by Congress.

Planning Specifics

The time between the onset of an accident, the release of significant quantities of radioactive material if not contained within the ship, and the arrival of the material at public areas will vary depending on the type of accident and dispersal conditions. For reactor accidents, the range is generally on the order of hours to a day. The duration of the release may vary from less than a hour (short-term release) to up to a few days (continuous release).

Radioactive materials produced in the operation of a nuclear reactor include fission products, transuranics, and activation products. Of these, fission products present the greatest potential problem if they should be released during an accident.

Fission products include many different radioactive isotopes. Most have a very short half-life, so that the amount of radioactivity decreases rapidly with time. Even in a very serious reactor accident with a large release, many of the fission products will have decayed before they could escape the area surrounding the reactor; their half-lives are short compared to the duration of the accident. Fission products may exist in a variety of chemical and physical forms with different volatilities, while virtually all transuranics and activation products are nonvolatile solids.

Gases will constitute most of the radioactivity released to the environment during an accident. The release of volatile solids would be less, with the escape of nonvolatile solids very minor. The source terms representing the hypothetical fission product activity within a reactor emphasize release of noble gases and/or volatiles such as iodine.

Considering the wide range of potential accident scenarios, planning should not be dependent on a specific area or zone. An accident involving a shipboard reactor would likely affect only the immediate area, although for a conservative accident meteorological conditions and local terrain will determine the path of airborne contamination and the resulting pattern of deposition. This pattern can be determined by the projection, monitoring, and assessment capabilities of the Navy. Timely projections of the

path of the potential or actual release would be made to identify the area affected and to communicate with civil authorities.

Public health consequences of an accident involving a release of radioactive material can be reduced or virtually eliminated by taking protective measures for any nearby affected population. In the unlikely event of an accident with public consequences, shelter and/or evacuation are the most appropriate immediate actions for people directly exposed to a plume of significant radioactive material. In most cases, shelter provides adequate protection and may be preferable to evacuation because it eliminates the significant risks of evacuating the affected population. Early actions to prevent or minimize subsequent contamination of any food or animal feed will reduce exposures through ingestion.

Specific accident conditions would affect the levels at which recommendations for evacuation or sheltering would be made. However, for planning purposes, projected off-site public doses of 5 roentgen-equivalent-man (rem) to the whole body, or 25 rem to the thyroid, would be used.

Emergencies at a Naval base that involve the release of radioactive material, or the expectation of such a release, outside the area controlled by the Navy are reported to State and local authorities by facility personnel. This notification will indicate the situation severity based on the nature of the event and the amount of radioactive material involved.

This notification would initiate an appropriate level of response for events ranging from those which involve only limited releases of radioactive material, warranting standby actions, to those which warrant making preparations for implementing actions to protect the public health and safety and the environment. Notification will also be made to initiate major activation of Federal resources to mitigate the consequences of an emergency condition depending upon the severity of the situation.

The initial recommendation associated with this latter case would probably be sheltering (asking the people to stay inside) until an assessment of the benefits of evacuation can be made. The decision to recommend evacuation would be based on (1) the amount and type of radioactive material in the release, (2) the expected duration of the release, (3) the time before the material is transported to public areas, (4) the time required for evacuation, (5) potential hazards to the public from moving vice remaining stationary, and (6) the ability to control the evacuation so as to avoid creating other adverse conditions.
The emergency response recommendations would be based on the seriousness of the event and the actual or imminent potential for release of radioactivity.

Response Actions

The following are actions that the Navy would take, as necessary, considering the events in progress:

Take immediate actions to minimize the consequences of the event.

Promptly inform State and/or local authorities of the event.

Augment resources and activate the emergency response organization.

Assess and respond.

Cooperate with appropriate Federal, State and local emergency management officials in response to the emergency.

Dispatch environmental monitoring teams.

Recommend appropriate response/protective actions to civil authorities (no action required, control access, issue public warnings, take preparatory steps for shelter or evacuation recommendations, issue shelter or evacuation recommendations, issue longer term ingestion guidance).

Provide periodic status updates to civil authorities.

Coordinate with civil authorities on the release of information to the public.

Provide periodic meterological assessments to civil authorities and, if releases are occurring, dose estimates and plume corridors of expected travel for actual releases.

Make senior personnel available for consultation with civil authorities as needed.

The following are actions which may be appropriate for civil authority response:

Augmenting civil response resources.

Alerting or deploying key civil emergency personnel.

Warning the public/controlling area access.

Considering the advisability of sheltering or evacuation.
Recommending protective actions to the public.

Providing information on the status of the emergency.

Continuously assessing information from the Navy.

Placing milk bearing animals in the affected area on stored feed.

Placing controls on agricultural products in the affected area.

Providing press briefings.

Safeguarding of Nuclear Materials

Operations at Everett do not involve the handling or storage of fissile materials. The only fissile material is that contained in the reactor core installed in the ships propulsion plant. This material is highly radioactive as a result of reactor operation and hence, even neglecting its secure location within the sealed reactor plant, does not constitute a target for potential theft or diversion. Physical protection will be provided at the site to prevent the access of unauthorized personnel to the ships. In addition, personnel security clearances are required for access to the reactor plant. Also, the same design criteria which protect against an accident during operation make the likelihood of a successful sabotage attempt negligibly small.

Conclusion

The Naval Nuclear Propulsion Program provides comprehensive technical management of all aspects of Naval nuclear propulsion plant design, construction and operation including careful consideration of reactor safety, radiological, environmental, and emergency planning concerns. The record of the Program's environmental and radiological performance at the operating bases and shipyards presently utilized by nuclear powered warships demonstrates the continued effectiveness of this management philosophy. It further demonstrates that application of the environmental practices which are standard throughout the Program will assure the absence of any adverse radiological environmental effect at the Everett, Washington homeport site.

Errata

Figure 2 of Appendix F of the DEISS was inadvertently omitted. It is included on the following page. The reader is directed to insert Figure 2 as Page 43 of Appendix F of the DEISS.

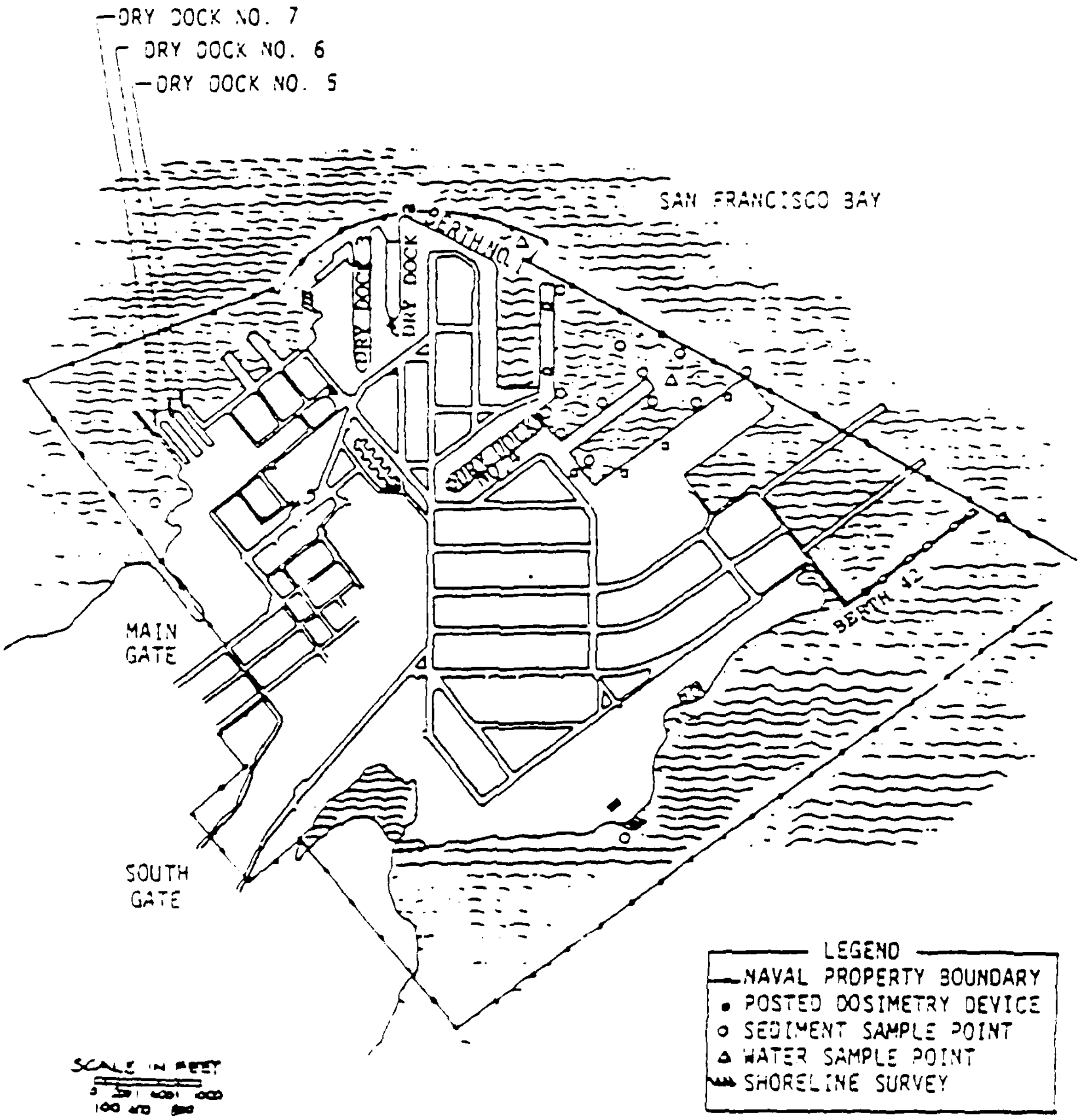
In Appendix F of the DEISS, the material following Figure 23 entitled "Environmental Monitoring Locations at Naval Submarine Base Bangor, Washington" was inadvertently included in the DEISS and is not germane to the EISS.

ENVIRONMENTAL MONITORING LOCATIONS AT THE

HUNTERS POINT SHIPYARD

SAN FRANCISCO, CALIFORNIA

FIGURE 2



12. UNAVOIDABLE IMPACTS AND MITIGATION

12.1 Summary of Impacts

Adverse and Beneficial Impacts Discussed in this EISS

The following paragraphs are not intended as a summary of all impacts associated with the homeporting project. The intention is to summarize only the impacts described in this EIS Supplement. Detailed discussions of other project impacts can be reviewed in the Navy FEIS.

Dredging/Dredge Disposal

- Impacts from dredging and dredge disposal are summarized in the following water quality and fisheries sections.

Water Quality

- Dredge and disposal impacts of the proposed project would result in the release of various contaminants to the water column. Based on recent laboratory studies with East Waterway sediments, water column concentrations (total and dissolved) of contaminants of concern are expected to be below U.S. EPA water quality criteria established for the protection of aquatic life. Mass release of sediment bound contaminated particles to the water column of Puget Sound would also occur. Such releases would result in the temporary spread of contaminants from the East Waterway during dredge and disposal activities. Because of the temporary and intermittent nature of these activities, impacts would also be temporary. Given adequate dilution, water quality impacts are anticipated to be minor.

- The project would result in the discharge of graywater to East Waterway from four of 15 ships berthed at the homeport. Adverse water quality impacts would be minor for the East Waterway as a whole, but may result in elevated levels of copper in quay areas adjacent to these discharges.

- The use of organotin antifouling paints on ship hulls could result in significant adverse impacts to water quality or to aquatic biota of East Waterway as a whole. Areas adjacent to ships may experience somewhat elevated concentrations of organotin resulting in impairment to localized biological communities. However, the Navy's commitment to use an EPA approved

TBT paint formulation will ensure that adverse impacts do not occur through the use of TBT. The Navy is not committed to conducting TBT monitoring in East Waterway until a determination of how many (if any) ships at Everett will be painted with TBT, until preliminary results from other harbors are available, and until EPA water quality and paint formulation criteria are available.

- Oil spills at the proposed facility may be expected to adversely impact water quality and related biota. Precautionary measures are anticipated to minimize the frequency and magnitude of such events.

- The potential for secondary impacts exists as a result of port relocation activities and increased housing and development associated with the Homeport project. Port relocation activities would require that approximately 6 percent more contaminated material be dredged and disposed of. The cumulative water quality and biota impacts of such activities are not expected to measurably surpass those predicted for the Navy homeport dredging and disposal activities. Cumulative impacts of operation, while difficult to quantify, will be related to the additive effects of oil spills, graywater discharges, organotin paint, and other, as yet, unforeseen operational activities. Degraded water quality could occur as a result of these activities; however, cumulative impacts of operations are expected to be minor for reasons discussed in the text. Increased housing and development could impact stream corridors and wetlands in the region.

Fisheries Resources

- Adult Dungeness crab would be impacted to some degree by disposal at either of the three Confined Aquatic Disposal (CAD) sites. The primary short-term impact would be due to burial, physical trauma or associated stress that would result from barge dumping of berm and contaminated materials. At the three alternative sites identified, this impact in a conservative analysis would kill about 15,000 female crabs at DD CAD, 990 females at SW CAD, and 800 females at RAD CAD. Some male crabs would also be killed; however, few occur at the depths of these sites. Prior to capping, some female crabs would be exposed to the same contaminated material that males are presently exposed to in the East Waterway. Contaminated material would be capped prior to the time females bear eggs, thereby preventing toxic impacts in the reproductive life stage. Recolon-

ization of any of the three CAD sites would begin immediately following cessation of capping activities in each of the two years. Substantial recovery is expected between FY 87 and FY 88. However, additional cap placed in FY 88 would destroy this recovery. By late spring to summer of 1989, the site would be expected to be repopulated by many, if not most, of the existing species of macroinvertebrates with population numbers approaching existing levels. The cap material has been shown to have grain size distribution characteristics similar to those at the existing site. Thus, long-term productivity of any of the CAD sites would be expected to be unchanged.

- Juvenile salmonids should not be significantly affected by the project. Dredging will not occur during a "fish window" (March 15 to June 15) designed to avoid major impacts to migrating juvenile salmonid populations. Alterations to the existing shoreline as a result of the project will increase both lineal and square footage of intertidal habitat.

- Juvenile Dungeness crab survival may decrease in the East Waterway due to alteration of preferred habitat. Not enough information is known about juvenile crab habitat requirements to quantify any decrease in survival, but it is anticipated that the proposed shoreline habitat is not as suitable as what presently exists due to the absence of bark that provides cover for the young crabs.

- A temporary loss of benthic and epibenthic production will occur in the East Waterway during dredging operations. This loss will have a short-term effect on demersal fish and adult crab production in that area. The relatively clean sediments that will be present following the dredging operation should support more diverse and abundant benthic and epibenthic communities, which in turn should provide better habitat for demersal fish and crab production in the area if upland sources of pollutants are removed.

Air Quality

- Traffic related emissions consist of carbon monoxide (CO), oxides of nitrogen (NO_X), and hydrocarbons (HC). Modelling estimates of CO emissions (the pollutant of primary interest for mobile sources) predicted that concentrations would be below the standards set by EPA.

- Non-traffic related emissions of NO_x would be slightly higher than the level considered significant by the EPA, but still far below the set standard.

Threatened and Endangered Species

- Neither project construction nor operation is expected to result in detrimental changes in the use of the area by threatened or endangered species.

- Biological assessments have been prepared and submitted to the U.S. Fish and Wildlife Service and National Marine Fisheries Service (Appendix D). Review by the National Marine Fisheries Service concluded that there will be no impact to Federally listed marine animals. The Biological Assessment for bald eagles concludes that the project will not result in any permanent habitual use changes in the area by bald eagles. This Biological Assessment is presently being reviewed by Fish and Wildlife Service.

Wetlands

- Neither dredging in East Waterway nor dredge disposal at the CAD site(s) are expected to result in impacts to wetland areas. The wetlands presently associated with the Snohomish River delta are a sufficient distance from the dredging and disposal locations that they will not be affected. Although some mass release of sediment-bound contaminated particles will occur, their effects will be negligible due to the distances of the existing wetlands from the project site. Therefore, no mitigation for wetland loss is considered necessary for the dredging and disposal operations at the CAD site(s). However, the Snohomish River Channel Disposal site and Smith Island Site do include wetland habitat. Accordingly, mitigation for the loss of this habitat will be required if either of these sites is chosen as the disposal location.

Soils and Geology

- Evaluation of historical data shows that the probability of occurrence of mass wasting is low due to the low sedimentation rates in the delta.

- The liquefaction assessment of project site soils indicated that soils in the upper 60 to 80 feet may liquefy at acceleration levels equal to or greater than 0.1 g. Liquefaction can result in limited vertical or horizontal displacements, loss of foundation support, slope failure, and/or settlement.

12.2 Mitigation

Mitigation measures as defined in the NEPA regulations (40 CFR 1508.20) include a range of actions that can be taken. These include: a) "Avoiding the impact altogether", b) "Minimizing impacts by limiting the degree or magnitude of the action", c) "Rectifying the impact by repairing, rehabilitating, or restoring", d) "Reducing or eliminating the impact over time by preservation and maintenance operations", and e) "Compensating for the impact by replacing". A number of mitigation measures were proposed in the Navy FEIS. The following section summarizes the measures that will be used to mitigate for impacts discussed in this EISS.

12.2.1 Dredging and Disposal Activities

As described above, the NEPA guidelines indicate that an action which minimizes impacts is a mitigation measure. Accordingly, EPA's guidelines for specification of disposal sites for dredged or fill material (40 CFR 230) include actions to minimize adverse effects (Subpart H). In designing the dredging and disposing operations for the homeport project, several of the actions recommended in the guidelines have been incorporated into the proposed dredging and disposal operations and therefore are acceptable mitigation for the dredging and disposal activities. A summary of the actions specified in Subpart H of the guidelines that have been incorporated into the design of the dredging and disposal operations follows:

- The cap of clean material that will be placed over the contaminated material at the proposed disposal site has nearly identical grain size characteristics as the existing sediments at the site.

- Clamshell dredging and bottom dump barge disposing of contaminated material have been proposed. These measures will tend to keep the material in its naturally occurring cohesive state thus reducing the availability of pollutant discharge during both dredging and disposing.

- The CAD sites (DD, SW,and RAD CAD) are located in an area where natural contours and slopes will tend to minimize erosion and slumping. The area includes an accretion zone associated with the Snohomish River delta and is not an erosion zone. The contaminated material will be capped in place with the remaining clean material from the dredge site.

- Placement of the mound of uncontaminated materials downslope of the contaminated materials will reduce the likelihood of spreading of contaminated materials due

to flow slides during placement or seismic events. This will be further considered in the design and placement of the mound.

- Disposal of the material will cover a wide area to create a gradual increase in elevation contours over what currently exists rather than creating a steep mound that is radically different than the existing contours. Also, the change in bottom contours at the site will be relatively small compared to the overall depth at the site.

- The dredging schedule will occur outside of a designated fish window (March 15 to June 15) that is intended to avoid major impact to populations of migrating juvenile salmonids. The disposal schedule calls for completing disposal of contaminated material by August of FY 87 and September of FY 88. This means that no contaminated material will be disposed during the period when ovigerous female crabs are present at the site.

12.2.2 Water Quality

Mitigation measures proposed here are intended to minimize or reduce anticipated adverse impacts to water quality and related biota arising from implementation of the proposed homeporting project.

12.2.2.1 Dredge and Disposal Methods

Because the majority of sediment contaminants (i.e., metals and organics) remain bound to the fine-grained sands, silts, and organic portion of the sediments, the control of these solids will in turn provide a high degree of contaminant control. Monitoring of water quality during dredge and disposal activities will ensure that control of suspended solids and associated pollutants is ongoing.

Mechanical (i.e., clamshell) dredging of sediments results in less disturbance and less opportunity for sediment-bound contaminants to be released to the water column than does hydraulic dredge removal practices. In addition, there is less opportunity for solubilization of sediment-bound contaminants. Dewatering of mechanically dredged sediments at the disposal site also produces less water than hydraulically dredging sediments.

Hydraulic dredging breaks up the cohesion of in place sediments resulting in dredge spoils that are difficult to control at the disposal site. Thus, the use of mechanical dredging will reduce potential impacts to water quality that would otherwise occur with hydraulic removal of contaminated sediments.

12.2.2.2 Graywater Discharges

There is no alternative to graywater discharge during port entry and exit. Navy regulations require that all available storage space in the wastewater holding system be reserved for blackwater (sewage) until ships are at least 3 miles from shore. Such conditions do not exist in Puget Sound south of the Strait of Juan de Fuca. However, under certain conditions i.e., when space is clearly available in holding/collection tanks, operators may elect to start holding graywater and to discontinue discharging into East Waterway. While this possibly exists, such conditions could not be counted on to occur consistently.

As stated previously, the four ships that would be discharging graywater in port do so because they have no internal collection system. Theses ships are a new class of vessels, essential to the battle group. They cannot be substituted with other existing Navy vessels.

The four ships' design is such that graywater is discharged from 15-32 ports scattered about on the hull. Two are below waterline and the remainder are above. External collection systems for this many discharge ports is obviously not practical.

The Navy has recently completed a draft feasibility study to retrofit the four vessels with the necessary plumbing to collect graywater in port similar to the other ships in the battlegroup. The Navy has determined that it is feasible to modify the vessels. Therefore, the proposed discharge would be temporary, perhaps two years, or possibly non-existent, depending on the homeport completion date and retro-fitting date.

12.2.2.3 Organotin Paint

The Navy is aware of the uncertainties regarding the environmental fate and effects of TBT. For this reason the Navy is proposing mitigating measures that should prevent significant adverse effects from occurring. The two key mitigating measures are (1) slow implementation of OT painting, and (2) use of low OT-release rate paints. The slow implementation rate would ensure that ambient TBT concentrations would not suddenly increase to unacceptable levels. Organotin-based paints would be applied to ships during regularly scheduled ship overhauls only. The implementation rate for applying OT paints to Navy ships would be 5 to 20 percent of the Fleet per year. The maximum implementation rate would be 20 percent per year because this is the percentage of the Fleet normally overhauled each year. At the maximum implementation rate the entire Fleet would not have OT paints until 1991. A more probable initial implementation rate is 5 to 10 percent per year (one-quarter to one-half of

ships to overhaul) because the use of new paints and new drydock procedures must be incorporated into Navy operations.

The above implementation rates apply to the entire Fleet. The implementation rate for specific harbors/homeports and types/classes of ships could, however, deviate from these rates. Painting implementation would follow the overhaul schedule (classified) and no geographic or type/class preference is anticipated.

The Navy uses and will continue to use a US EPA approved paint formulation for TBT. In this regard, the Navy will also comply with any future EPA criteria for water column concentrations of TBT resulting from ship hull applications of TBT.

12.2.2.4 <u>Water Quality Monitoring</u>

Various activities related to project construction and operation will require that water quality be protected. Therefore, during such activities, water quality monitoring will be conducted in areas potentially impacted. Such monitoring will provide data with which to determine the adequacy of control measures, structures, plans, and safeguards employed to protect water quality and related biota. Should such control measures prove inadequate (based on water quality monitoring data), modifications to plans and/or methods of construction will be made to alleviate impacts. No attempt has been made to identify the "trigger" levels which will necessitate modifications to the plans and/or methods of construction. It is anticipated that the "trigger" levels will be identified in the monitoring requirements of the necessary project permits. These levels will be determined in part by the regulatory agencies responsible for water quality protection.

12.2.2.4.1 <u>Dredge and Disposal Monitoring</u>

The following monitoring would take place during (and after) dredge and disposal activities for the CAD alternative:

(a) Sediment resuspension and contaminant release to the water column during dredging and transport (total suspended solids (TSS), ancillary chemical and physical parameters, and analysis of identified contaminants of concern);

(b) Sediment remaining in suspension and contaminant release during placement (TSS, ancillary chemical and physical parameters and analysis of contaminants of concern);

(c) Physical placement of dredge material through precision

disposal area positioning techniques and of cap thickness; and

(d) Migration of contaminants through cap after placement of cap material (analysis of identified contaminants of concern and ancillary chemical and physical parameters).

A comprehensive monitoring program covering each of the above phases of dredging and disposal is being developed by the Navy in conjunction with the appropriate regulatory and resource agencies prior to the initiation of dredge and disposal activities. Appendix B contains a variety of monitoring elements developed by WES that are being evaluated by the Navy. The Navy's monitoring program will be closely coordinated with the PSDDA monitoring program for the proposed Port Gardner PSDDA disposal site located approximately 3000 feet west of the RAD CAD site (measured from edge of PSDDA site to edge of RAD CAD site).

12.2.2.4.2 Graywater Monitoring

In order to insure that water quality standards are met as a result of graywater discharges, routine water and biological samples will be collected and analyzed for contaminants of concern. The Navy and appropriate regulatory and resource agencies will develop a specific monitoring program prior to the arrival of the ships. If monitoring indicates that the graywater discharges are significantly impacting water quality and/or biota, then efforts will be made to accelerate the retro-fitting schedule.

12.2.2.4.3 Ancillary Water Quality Monitoring

During operation of the proposed Navy Homeporting facility, routine water quality monitoring would be conducted in the quay areas adjacent to ships and ship berthing areas. Water, sediment, and biological samples collected would be analyzed for oil and grease, contaminants of concern present in graywater, and any other parameters deemed important or necessary by appropriate regulatory agencies. Such information would provide data with which to assess any unforseen adverse water quality impacts resulting from operation of the project. If unforseen adverse impacts to water quality are identified, measures will be taken to alleviate such impacts.

12.2.3 Fisheries Resources

12.2.3.1 Shoreline Alterations

The following measures are proposed as mitigation for impacts to fisheries resulting from shoreline alterations associated with homeport development. These measures include:

BREAKWATER GAP A gap between the breakwater for the carrier pier and the south mole has been incorporated into the project design. This gap is designed to lead fish along the same migration route through East Waterway that is currently used. Fish that use the gap would not need to migrate around the breakwater where they would be led to deeper water than they would normally encounter in their migration. The gap will be approximately 12 feet wide at the bottom, and will have a maximum depth corresponding to -7.5 MLLW.

PIER/LIGHT ACCESS The proposed project design includes 1,800 lineal feet of wharf (Central Marginal Wharf) along the western shoreline of East Waterway. Wharf design will allow passage of light to the intertidal shoreline along the entire length of the pier. The wharf deck will be constructed approximately 80 feet from shore; access to the deck will be provided by ramps from the shore to the deck. Three to four access ramps will be built perpendicular to the 1,800 foot length of the wharf. Sufficient light will be provided under these ramps, since they will be relatively narrow and elevated above the water surface allowing light penetration around either side of the ramp. This design will not discourage or prevent juvenile salmonids from using the intertidal habitat adjacent to the wharf due to lack of light. Light penetration in the nearshore area adjacent to the wharf will likely stimulate the growth of intertidal flora and benthic fauna and encourage fish to utilize the area.

COMPOUND SLOPE/INTERTIDAL BENCH The shoreline located in the Snohomish Channel along the west side of the Central Marginal Wharf will consist of a compound slope. Use of a compound slope will create an intertidal bench that is gently sloping and has small substrate consisting of sand, gravel, and rocks. The bench will be 1,700 feet long, 70 feet wide, have an 8.75:1 slope, and be located parallel to shore between approximately +5 and -3 feet MLLW. The bench will create about 8,500 square feet of quality intertidal and shallow subtidal habitat for migrating/rearing juvenile salmonids. The slope above and below this bench will be 2.5:1 thus creating a shoreline with a compound slope. It should be noted that this general concept is acceptable to the resource agencies, but specific details regarding slope and substrate of the bench may require revision to prevent such things as fry stranding.

12.2.3.2 Dredging

Mitigation measures proposed to minimize the impacts of dredging are focused on protecting juvenile salmonids and providing a better habitat for fisheries resources when dredging is complete.

JUVENILE SALMONIDS Juvenile salmonids will be protected from adverse affects of dredging by recognizing a "fish window" when dredging will not occur. This window will extend from March 15 to June 15, encompassing the period of major juvenile salmonid outmigration. No in-water construction work (with the exception of pile tests), including dredging, will occur during this time period. It has been documented that juvenile salmonids are present in the East Waterway vicinity after June 15 (Navy FEIS, Appendix C; Tulalip Tribes, 1986). Dredging impacts to fish present after June 15 will be minimized due to their pelagic nature and the fact that they are of sufficient size to avoid the majority of the impacts.

EAST WATERWAY CLEANUP In addition to removal of sediments to the depth required for the proposed homeport project, 54,000 cubic yards of contaminated sediment below project depth will be removed. The clean-up of East Waterway is an immediate beneficial impact of the project. For this to remain a long-term benefit, measures must be taken to insure that the source(s) that caused the existing degraded environment are controlled to prevent recurrence. Also, measures must be taken to insure that future activities and discharges to the East Waterway do not cause a recurrence. The Navy is willing to do its part to prevent a recurrence in the future. However, it is neither its function nor within their jurisdiction to implement controls on other parties that may be responsible in part for existing degraded conditions. Such controls will need to be implemented by the appropriate regulatory agencies.

12.2.3.3 Disposal Operations

12.2.3.3.1 CAD Site(s)

Dredge disposal operations at the CAD site will impact biological resources and habitat that occur at the site. A variety of measures are available to minimize the impacts to the resources and their habitat. These measures involve the timing of the disposal operation, use of a clean native material as a cap to isolate the contaminated dredge spoils, and placement and depth of the cap material.

CAPPING MATERIAL Use of clean native sediments as a cap will isolate the contaminated sediments from the environment. A minimum cap thickness of 1 meter will cover the entire disposal area. Although only 30 cm of clean cap are necessary to isolate the chemical contaminants from migrating upward through the cap, at least a one meter cap will be used to ensure that contaminants are not exposed to the environment through bioturbation. The grain size of the cap material will be nearly identical to the grain size charac-

teristics of the sediments that currently exist there. This similarity in grain size should maximize the recolonization potential of the area by the biological resources that currently use the site.

DISPOSAL TIMING Adult Dungeness crab have been found on the sites. During the February sampling cruise ovigerous females were relatively abundant on the CAD sites compared to males and nonovigerous females. In order to minimize the potential impacts of smothering gravid females which may be prone to burying into the sediments and to prevent exposure of eggs to contaminated sediments, disposal of contaminated material will not occur during the period when ovigerous females are present at the site. This is based on the current disposal schedule which calls for completing disposal of contaminated material by August of FY 87 and September of FY 88.

CAP PLACEMENT Placement of the clean cap will be conducted in a manner designed to minimize the areal and temporal extent of contaminated sediment exposure to the environment. Since a hydraulic slurry discharge will be used to dispose of the clean sediments, it will be possible to spread a thin layer of clean material over the entire area to contain contaminated sediments. This can be accomplished in a timely manner, thus minimizing the duration of direct exposure of contaminated sediments to the environment. After placement of a thin layer of clean material over the entire disposal area, disposal operations will continue to facilitate cap placement to final design depth (one meter or greater) throughout the disposal site.

HABITAT DEGRADATION Impacts on habitat are expected to be short-term. While these impacts are unavoidable, measures will be taken to minimize them. These measures include the cap material, cap placement, and disposal timing as described above.

BIOLOGICAL RESOURCES LOST Direct losses of biological resources (crab, shrimp and bottomfish) will occur as a result of the disposal operation. Efforts to relocate the CAD site have been made at the request of resource agencies. Although the efforts have minimized the impacts by moving the CAD site to the deepest practical location (RAD CAD), nevertheless direct losses will occur. No attempt has been made to categorize the losses as a major or minor because such categorizations vary depending on the perspective from which they are made. The direct losses are an unavoidable adverse impact. No reasonable mitigation is available to compensate for this direct loss. As discussed earlier, mitigation measures have been presented for indirect losses (i.e., habitat, contaminant exposure, etc.).

EAST WATERWAY CLEANUP Temporary impacts to the crab habitat at the CAD site may occur while the benthic community recolonizes. The cleaner habitat in East Waterway, as a result of removing the contaminated material, will likely provide better crab habitat than exists there presently. The cleanup of East Waterway will improve Dungeness crab habitat and therefore, can be considered as a beneficial measure.

12.2.3.3.2 Snohomish River Channel Site

Disposal at the Snohomish River Channel Site will result in the loss of 155 acres of intertidal and wetland habitat. While this location is a practical alternative in terms of containing the contaminated material, the Navy has never considered it environmentally feasible due to the magnitude of nearshore habitat that would be lost. Therefore, this location was not chosen as the preferred alternative, and is not considered as a feasible second or third alternative.

In compliance with NEPA, mitigation measures for this alternative have been considered. Basically, the mitigation would be to replace the lost habitat. The level of replacement has not been identified, but at a minimum would be a 1:1 ratio of lost to replaced. Replacing the habitat would require procuring (either purchase or lease) a significant amount of intertidal and wetland habitat in the Snohomish River delta vicinity. The first step in the mitigation process would be to identify what properties are available and evaluate how they compare with the habitat that will be lost. At this point, mitigation costs have not been included in evaluating the Snohomish Channel alternative, but it is anticipated that they would add significantly to the overall cost of the alternative. Identifying accurate mitigation costs is not feasible until a determination of which and how much property will be procured.

12.2.3.3.3 Smith Island Site

Disposal at the Smith Island site will result in the loss of some wetland habitat. The extent of this loss depends on the disposal operation method. Currently substantial wetland communities exist between the present dike and shore of the island. A portion of these communities would be destroyed if barge offloading of dredged material is the disposal method. This temporary loss would be mitigated by recreating the wetlands after the disposal operation terminated. These wetlands will not be impacted if hydraulic pumping of dredge spoils is the disposal method.

Less than one acre of wetland habitat will be lost on the upland side of Smith Island as a result of dredge disposal, regardless

of the disposal method. Loss of this habitat could be mitigated for by creating an equivalent amount elsewhere on Smith Island during its development as a disposal site.

Placement of contaminated materials in a nearshore or upland configuration may result in contaminant release to surface or groundwaters. Such impacts can be largely controlled through such measures as surface cap of clean materials, site liners, and leachate collection/treatment. However, such solutions are highly dependent on site variables such as groundwater levels and movement, soil structure, resource exposure, and site capacity/-options. Nearshore or upland disposal will incorporate field studies and a final design to control contaminant release. While it is possible to commit to this type of mitigation, at this time, it is not possible to determine costs. Depending on the variables described above, the cost for providing contaminant release control could vary substantially. Therefore, mitigation costs could add substantially to the overall costs of this alternative.

12.2.4 Secondary Impacts

Local jurisdictions have defined environmentally sensitive areas such as steep slopes and stream corridors and have taken measures to protect them from impacts of future growth. In addition, any significant local development would be reviewed through either state or local environmental policy regulations and federal regulations, if applicable, so that adequate environmental protection measures can be taken.

12.2.5 Native Americans

The Navy has met and plan continued negotiations with the Tulalip Tribes to develop mutually acceptable mitigation measures for potential impacts on the Tribes associated with homeport development.

12.2.6 Traffic and Transportation

The Navy will contribute to the cost of access improvements to the proposed homeport. Detailed design of the access route has not been completed; consequently, no firm cost figures have been agreed upon.

To minimize traffic impacts the Navy will encourage carpooling and use of staggered hours. The Navy will coordinate with the City of Everett traffic engineer when major changes in traffic volumes are anticipated so that signals can be set accordingly.

The Navy will operate a shuttle bus between the proposed homeport and Naval Station Seattle to help reduce traffic volumes.

12.2.7 Population and Housing

The Navy housing assistance office will work with Snohomish County and local planning departments to exchange information on where Navy-related growth is taking place to assist in growth management planning. Navy social service personnel will cooperate and assist civilian health and social welfare agencies in providing care to Navy-related personnel and families.

12.2.8 Soils and Geology

Design of the facilities considered earthquake impacts, including the potential for and intensity of ground shaking, ground rupture due to faulting, liquefaction, and ground displacement due to land sliding.

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